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VOL. 40, No. 4 APRIL 1959

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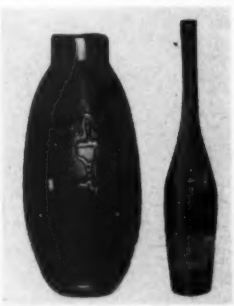

This Month's Cover

Two pieces of contemporary international glassware from a selection of 284 which will be on exhibit at the Corning Museum of Glass, Corning, N.Y., June 1 through September 15. Eighty-five manufacturers and 22 countries throughout the world will be represented and will provide glass scholars an opportunity to study new trends in world glass designs. Exhibit will also be held at other leading museums in the United States through 1960.

THE GLASS INDUSTRY

An Ogden Publication Devoted to Glass Technology, Engineering, Materials and Glass Factory Equipment and Operations

Published by
OGDEN PUBLISHING COMPANY
55 West 42nd Street, New York 36, N. Y.
K. W. OGDEN, Owner

Editor	FRANK S. CHILD
Advertising Director	ROBERT M. OGDEN
Production Manager	IRENE ANNE YUSS
Circulation Manager	JOSEPH A. TEDESCO
Midwest Representatives	Macintyre-Simpson & Woods 75 East Wacker Drive, Chicago 1900 Euclid Ave., Cleveland
England	T. J. Scott & Sons Ltd. 1 Clements Inn, Strand London WC 2.

THE GLASS INDUSTRY is published monthly by Ogden Publishing Company, 55 West 42nd Street, New York 36, N. Y. Subscription $4.00 a year. Canada and Foreign $5.00. Single copies 50 cents domestic; 60 cents Canada and Foreign. Issues over three months old 70 cents; over one year, $1.50; over five years, $2.00. Second class mail privileges authorized at New York, N. Y.

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American Ceramic Society Annual Meeting

• OVER 220 TECHNICAL PAPERS are to be delivered at the 61st annual meeting of the American Ceramic Society in Chicago, from May 17-21 at the Palmer House. This is the largest number of papers ever to be offered at an annual meeting. According to the preliminary program 20 papers will be presented by the Glass Division; 38 by the Basic Science Division; 25, Design Division; 33, Electronics; 20, Enamel; 4, Materials and Equipment; 43, Refractories Division; 16, Structural Clay Products; and 28, White Wares.

It is hoped that Professor H. Salmang, of the Technischen Hochschule, Aachen, Germany, will be able to attend and present a paper on "The Structure of Glass Seen from an Atomistic Aspect and from a Molecular Aspect."

Professor Salmang is technical director of DeSphinx in Maastricht, Nethelands.

Dr. Wladimir Philippoff, of Franklin Institute, Philadelphia, will give the closing talk at the Symposium on the Behavior of Glass in the Viscoelastic Range. This Symposium has been organized by Dr. Howard R. Lillie of Corning Glass Works.

New Officers

Richard S. Bradley, vice president and director of research, A. P. Green Fire Brick Co., will preside over the important Annual Meeting as president of the Society. He will also conduct the general session and business meeting of the Society on Monday morning, as well as the semi-annual meeting of the Board of Trustees, and the banquet, on Tuesday night.

Oscar G. Burch, vice president of engineering and research, Owens-Illinois Glass Co., will be installed by Mr. Bradley as the 1959-60 president, while the new vice presidents will be J. J. Canfield, Armco Steel Corp.; John H. Koenig, Rutgers University; and James I. Mueller, University of Washington.

New trustees include A. C. Siefert, Owens-Corning Fiberglas (Glass Division); C. J. Koenig, Ohio State University (White Wares Divison); Albert H. Couch, Libbey-Owens-Ford Glass Co., (for the National Institute of Ceramic Engineers); and Joseph A. Pask, University of California (Ceramic Educational Council).

Frank R. Bacon, Owens-Illinois, is to become 1959-60 chairman of the Glass Division; while Guy E. Rindone, Pennsylvania State University, will be installed as vice chairman; and Fay V. Tooley, University of Illinois, as secretary.

Honors

Two honorary members will be named to the Society this year, which established a precedent over previous years. In addition, 24 members will be elevated to Fel-

(*Continued on page* 208)

GLASS DIVISION PAPERS

1. *Evaluation of Several New Infrared Transmissive Glass Systems.* Francis C. Lin, Westinghouse, Pittsburgh, Pa.
2. *Further Studies of the Nucleation of a Lithium Silicate Glass.* Guy E. Rindone, Penna. State Univ., University Park, Pa.
3. *The Relative Acidities of Glasses Containing Al_2O_3 and TiO_2 as Determined by the Oxygen Electrode.* D. E. Day, R. Caporali, and G. E. Rindone, Penna. State Univ., University Park, Pa.
4. *Crystallization of a Sodium Disilicate Glass.* William D. Scott and Joseph A. Pask, Ceramic Labs., Univ. of California, Berkeley, Calif.
5. *Internal Friction of Simple Glasses Containing Alkaline Earth Oxide Additions.* R. J. Ryder and G. E. Rindone, Penna. State Univ., University Park, Pa.
6. *The Viscoelastic Behavior of Solids.* Edwin R. Fitzgerald, Penna. State University, University Park, Pa.
7. *The Viscoelastic Behavior of High Polymers.* Hershel Markovitz, Johns Hopkins Univ., Baltimore, Md.
8. *Deformation of Glass Under Changing Loads.* F. F. Y. Wang, A. O. Smith Corp., Milwaukee, Wis.
9. *Rate of Stress Release in the Viscoelastic Range.* D. A. McGraw, Owens-Illinois Technical Center, Toledo, Ohio.
10. *The Internal Friction of Glass in the Transformation Range.* L. E. Ashman and Neill M. Brandt, Mellon Institute, Pittsburgh, Pa.
11. *Relation of Photoelastic and Visco-Elastic Behaviors.* Harold T. Smyth, Rutgers, The State Univ., New Brunswick, N. J.
12. *Strength and Viscoelastic Model of Soda-Lime Glass at Temperatures from 1,000°F to 1,400°F.* Theodore C. Baker, Owens-Illinois Technical Center, Toledo, Ohio.
13. *The Strength and Static Fatigue of Abraded Glass Under Controlled Ambient Conditions—III. The Effect of Various Abrasions and the Universal Fatigue Curve.* R. E. Mould, Preston Labs., Butler, Pa.
14. *The Structure of Glass As Seen From An Atomistic Viewpoint and From A Molecular Viewpoint.* H. Salmang, Maastricht, Netherlands.
15. *Transference Numbers For Water In Molten Sodium Silicates.* J. R. Hutchins, III, Mass. Inst. of Tech., Cambridge, Mass.
16. *Improved Apparatus For Rapid Measurement of the Viscosity of Glass At High Temperatures.* Ralph L. Tiede, Owens-Corning Fiberglas Corp., Research Center, Toledo, Ohio.
17. *Tempering of Glass Tubes.* Oscar H. Grauer and Victor P. Head, Fischer & Porter Co., Hatboro, Pa.
18. *Crushing Resistance of Glass Receiving-Tube Envelopes in a Gas Pressure Chamber.* John Gallup, Electron Tube Div., Radio Corp. of America, Harrison, N. J.
19. *Observations of the Plastic Deformation and Fracture of Glass Under Concentrated Forces.* O. K. Salmassy, AVCO Mfg. Corp. Research and Advanced Development Div., Wilmington, Mass.
20. *Paper On Glass Refining.* Michael Cable, University of Sheffield, England.

A Straight-Line Inspection Method for Glass Containers

By L. F. ROBERTSON,
Vice President, Engineering & Research
Brockway Glass Co., Brockway, Penna.

• BECAUSE WE FELT there was something basically wrong about the traditional inspection methods used in the glass container industry, we decided to make a detailed study of these procedures in our own plants. The more we analyzed the various phases of the work, the more we realized that we had to make a significant change in production techniques at the end of the annealing lehrs. Up to that point, our product moved forward in a continuous flow, which is characteristic in all process industries.

Fig. 1. Three flat-top chain conveyors at discharge end of lehr move containers clear of machine.

Fig. 2. Conveyors arranged to move containers past automatic inspection devices, which are shown covered because of their light-sensitivity.

When the cooled ware arrived at the end of the lehrs and passed into the inspection area, however, we found that all semblance of flow ceased in the operations connected with that phase of production.

Prompted by these observations, we began to figure out how we could extend the principle of continuous-flow production beyond the lehrs and right through inspection. However, before we describe the improvements we have made in our inspection layout and techniques, and the resulting benefits in both our customer service and product quality, we must take a more detailed look at the old methods which have been displaced.

The procedures used for inspecting glass containers

Fig. 3. An operator stationed before a visual inspection unit.

Fig. 6. Alternate arrangement, in which a rotary accumulating table gathers containers for the packers.

are so uniform that they amount to what might well be called standard practice for the industry. Operators are stationed around the discharge end of the annealing lehrs. Each individual in the group acts in the dual capacity of inspector-packer. She performs a set sequence of operations which include: picking up as many containers as she can hold, rolling them in her hands while, at the same time, inspecting them for defects and then placing them in a carton. The only break in this routine occurs when a defective container is discovered and discarded.

When the work area and the operations involved in this traditional *modus operandi* are examined critically, it becomes evident that two closely inter-related factors are responsible for its inherent limitations. The number of containers that can be processed in a given time is directly proportional to the number of operators which can be stationed about the lehr. Concentration of the pick-up-inspect-pack cycle of operations in individuals places a definite limit upon what each can turn out in a specified period of time.

In great measure, the number of operators that can be grouped at the end of the lehrs is a matter of space availability. Not only must personnel be accommodated, but space must be provided for cartons, packing bucks and cullet tubs, or other means used to handle discarded cullet. And space in most plants is critically short at this particular location. The usual practice is to have the lehrs discharge near the far end of a building, so that the only practical way to provide more floor area has been to make additions to the existing building.

Fig. 5. A reciprocating arm automatically regroups bottles from single line onto wide belt.

In making our break with traditional methods of inspection we have literally made space without having to resort to costly structural alterations.

Continuous Flow Through Straight-Line Inspection

When we came to the problem of carrying the principle of continuous production flow through inspection, we found we had to make radical changes in both our layout and our procedures. What we have worked out might

Fig. 4. Two visual inspection stations are provided here.

be called progressive, straight-line inspection. The first step in our revised setup is to discharge containers, as they reach the end of a lehr, onto a system of conveyors. These are placed close to and across the end of the annealing lehr. To facilitate this transfer and to protect the virgin glass from being injured, the containers are sprayed with a fine film of lubricant just before they reach the crossover point.

The number of discharge conveyors varies in our different plants. They invariably operate perpendicular to the travel of the lehr belt; however, they may be arranged to run in any one of several different combinations.

1. They may all be driven in the same direction.
2. Some may run in one direction while the others move in the opposite direction.
3. All the conveyors may have the same speed.
4. Each conveyor may be driven at a slightly different speed.

These selective arrangements are necessary to provide for possible variations in subsequent operations. For example, it may be preferable to direct the containers through inspections along a single conveyor line, or conditions may be such that these operations can be performed more satisfactorily when the containers are diverted to two or possibly three lines.

When containers are carried away from the discharge end of a lehr, there is no need for stationing operators at that point; instead the operators are positioned along inspection conveyors which are set up to make the best use of available work space in each particular plant. Where there is sufficient room, inspections can be carried on along conveyors which run in the same direction as the lehr belt.

In one plant, where space is limited, we have had to run the conveyor parallel with the lehr, back toward the forming machine. In this case the conveyor belt operates in the opposite direction to that of the belt on the lehr.

Fig. 7. A chute for directing rejects down to the cullet conveyor.

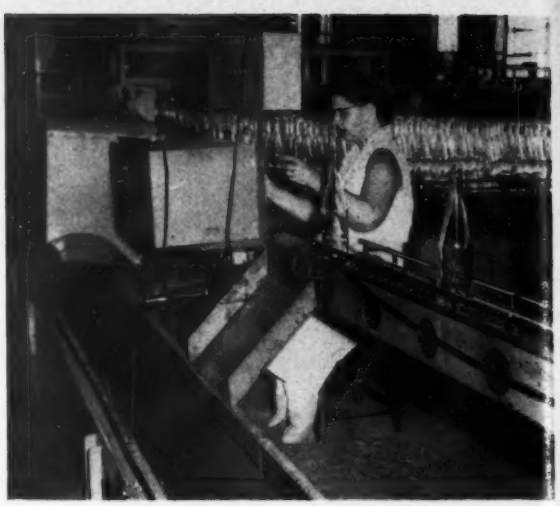

Fig. 8. Each inspector discards her rejects down a chute which leads to the same cullet conveyor.

Effects of Progressive Inspections

We no longer have each operator check for all types of defects and then pack the passed containers in cartons. This all-inclusive type of operation has been broken down into a series of distinctive, separate steps, with some very noteworthy results. We now have sufficient room to install automatic inspection equipment along the conveying lines. Secondly each inspector is able to concentrate on specific defects. This kind of specialized inspection has minimized the likelihood of defective containers reaching the pack-off station; returns are substantially fewer than before.

Automatic inspecting devices remove the element of human judgment in the detection of certain defects. Increased consistency in selectivity means more uniformity in delivered ware. The following are typical of the inspections possible with automatic equipment.

1. Checking physical dimensions such as height and width by limit gages which pass only those containers meeting specifications.
2. Testing for finish by roughness indicators that "feel" the containers for shear marks, soft blisters, poor mold match, and other deficiencies, so that those bottles which would not seal correctly will be rejected.
3. Detecting minute internal and external fractures that would tend to weaken the container to such an extent that it cannot stand up under thermal and mechanical shocks while on the filling line and in transit.

Since mechanical devices cannot perform all the inspections we feel are essential, we still use operators to make certain visual checks. These operator stations are illuminated by special kinds of lights, arranged to accentuate the particular defect which is being searched out. The containers are carried through the stations on conveyors, so the operator at any one location merely looks

(*Continued on page* 208)

Heat-Resistant Zinc Borosilicate Glasses

The zinc borosilicate glass-forming system was investigated at the National Bureau of Standards to obtain a thermal-shock-resistant glass of optical quality. Glass specimens were prepared in the laboratory by varying the content of the three major components, ZnO, B_2O_3, and SiO_2. Properties which were determined for these glasses include sag point, liquidus temperature, refractive index, modulus of elasticity, thermal expansion, chemical durability, and surface devitrification.

• THE GLASS-FORMING REGION of the zinc borosilicate system has been investigated in work[1] conducted at the National Bureau of Standards for the U.S. Air Force. All of the glasses that were prepared had low thermal expansions—in some cases as low as those of the well-known heat resistant-type glasses used for laboratory and household ovenware. As the zinc borosilicate glasses can be melted at moderate temperatures, they lend themselves to the production of glasses of an optical quality which is extremely difficult to obtain with the high-melting, commercial heat-resistant glasses.

Glass that can resist both high temperature and thermal shock and yet maintain good optical quality is needed for glazing windows in supersonic aircraft so that visual and photographic observations can be made with a minimum of distortion.

A number of properties, including tensile strength, thermal expansion, elastic modulus, thermal conductivity, density and specific heat, affect the thermal shock resistance of a glass. However, thermal expansion and Young's modulus are two of the factors that can be accurately determined and which should give an indication of the relative thermal shock resistance of different glasses.

As a zinc borate glass had been reported to have a low thermal expansion and other extreme properties, E. H. Hamilton, R. M. Waxler and J. M. Nivert, Jr. of the Bureau staff surveyed the composition range of the zinc borate and zinc borosilicate glass systems (Fig. 1).

Of the 42 different compositions that were melted, 26 produced homogeneous glasses, the compositions of which were within the following limits in mole per cent: 50 to 60 of zinc oxide; 20 to 50 of boric oxide; and 0 to 20 of silica. Very fluid melts were obtained between 1100°C and 1300°C, a factor that aided materially in producing homogeneous melts.

The following properties of these glasses were then investigated: sag point, liquidus temperature, refractive index, modulus of elasticity, thermal expansion, chemical

(*Continued on page* 209)

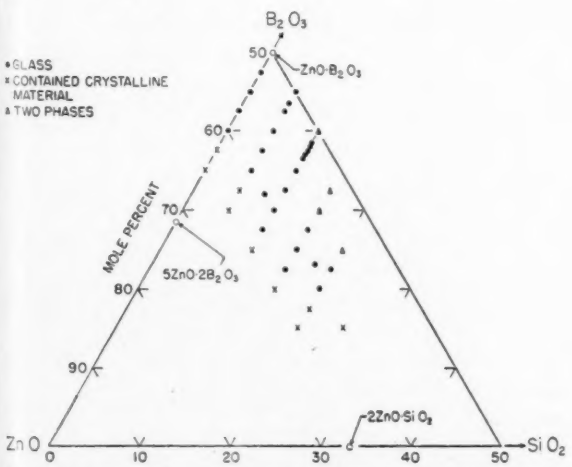

Fig. 1. Composition diagram indicating the glass-forming region of the zinc borosilicate system investigated at the National Bureau of Standards.

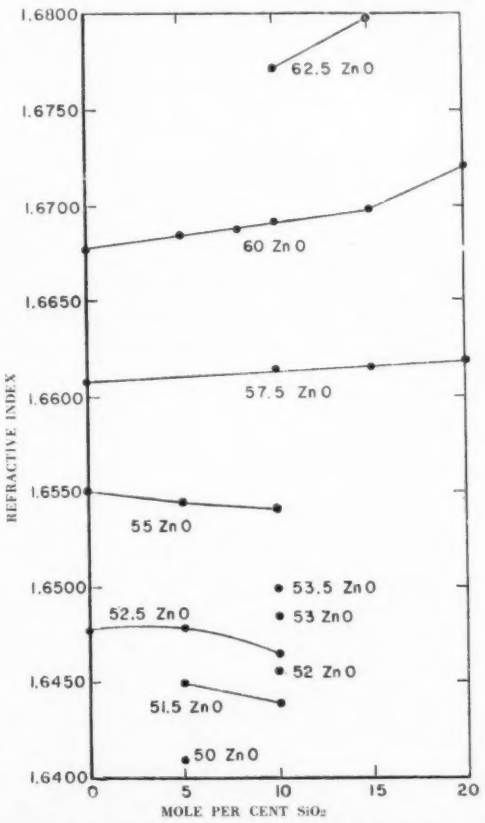

Fig. 2. Graph showing the refractive indices of various zinc borosilicate compositions investigated at the National Bureau of Standards.

The Evaluation of Several Infrared Transmissive Glasses

By R. B. GREKILA AND H. D. ROOT
Materials Engineering Departments
Westinghouse Electric Corporation,
Pittsburgh, Pennsylvania

• THE PROCEDURES FOR THE PREPARATION and evaluation of several series of glasses are described with particular attention to their infrared transmission in the range 1 to 5 microns and at temperatures up to 400°C. The effects are shown of various constituents in the compositions of three series of oxide glasses:

(1) Barium, tellurium, lanthanum and either aluminum or arsenic

(2) Barium, titanium and silicon in varying proportions

(3) Barium, calcium and aluminum modified by varying amounts of one or more of the oxides of silicon, sodium, lithium and potassium.

Some comments are made on vacuum induction melting, and some preliminary results of the effect of temperature in infrared transmission are demonstrated. Several of the glasses described are suitable for use as infrared windows in various wavelength bands between 1 and 5 microns.

This study of special glass compositions was undertaken to survey probable infrared transparent window materials. (Armed Forces usage of these windows has caused them to become known as Irdomes, an abbreviation of the words InfraRed Domes.)

The function of an irdome is to protect an airborne infrared detection cell from rain, dust, and air friction. Infrared detection and guidance systems may be used in the near future to augment radar.

The ultimate requirement for an irdome is that it transmit at least 80 per cent of all incident radiation from 1 to 6 microns. Particular systems will, no doubt, be designed for the selection and detection of particular narrow wavelength bands in this scanning range. With this kind of system, it will be possible to "see" (by radiation detection) anything from a steel mill to the exhaust plume of a high-speed jet aircraft.

Materials

There are many well-known single crystal materials which are transparent in the 1 to 6 micron range. These materials must, however, be capable of (1) being heated by air friction to perhaps 500°C, (2) being fabricated into hollow hemispheres 6″ in diameter and larger, and (3) withstanding such atmospheric conditions as instantaneous thermal shock, impact, and rain. The inability of most crystals to meet these requirements has caused development activities to be concentrated on the exploration and evaluation of several promising glass compositions. A tabulation of crystalline materials and their properties as given in the literature are shown in Table I.

Although some of the commercially available crystals exhibit the required transmission characteristics, they are disqualified by one or more of the following properties: low melting points, low abrasion resistance, sensitivity to moisture, and degradation by visible and ultraviolet light.

Crystalline alumina and magnesia (sapphire and periclase) have better physical characteristics than the non-oxide crystals, but have poorer transmission properties and are difficult to fabricate.

Although many of the glasses reported in the literature (Table II) are reported to have appreciable transmission between 2 and 6 microns in thicknesses of about 1 mm, their transmission drops rapidly as the thickness is increased. These glasses, however, are much more resistant than most crystals to atmospheric moisture, high temperatures, and ultraviolet radiation.

Since the infrared transmission of most glasses can be considerably improved by altering composition, improving melting techniques and developing anti-reflectance coatings, glasses rather than crystalline materials were chosen for this investigation.

Experimental Procedure

After several preliminary trials to determine the approximate melting and annealing procedures three series of oxide glasses were chosen for investigation.

(1) Barium, tellurium, lanthanum and either aluminum or arsenic

(2) Barium, titanium and silicon in varying proportions and

(3) Barium, calcium and aluminum modified by varying amounts of one or more of the oxides of silicon, sodium, lithium and potassium.

Each composition was weighed, mixed, put into a fire clay crucible and fired for three hours at 2200°F. Frequent inspection was made during the firing cycle to determine the melting point of each batch, which in most cases was near the temperature 1500°F. After melting, each batch was removed from the furnace and air-

Presented at the 60th Annual Meeting (1958) of the American Ceramic Society at Pittsburgh, Pennsylvania April 29 (Glass Division, No. 12-G-58) and released for publication in THE GLASS INDUSTRY. The authors are respectively supervising engineer and manager, Ceramics Section, Materials Engineering Departments, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania.

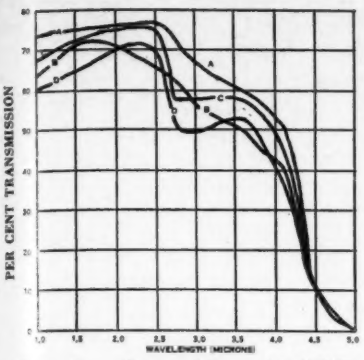

Fig. 1. Composition: A—0.265 CM; B—0.280 CM; C—0.293 CM; D—0.343 CM.

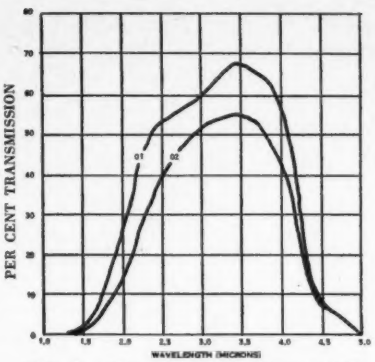

Fig. 2. 01—0.274 CM; 02—0.415 CM.

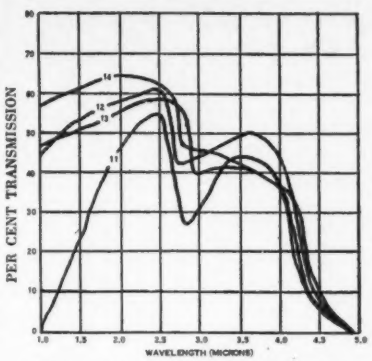

Fig. 3. 11—0.415 CM; 12—0.355 CM; 13—0.368 CM; 14—0.348 CM.

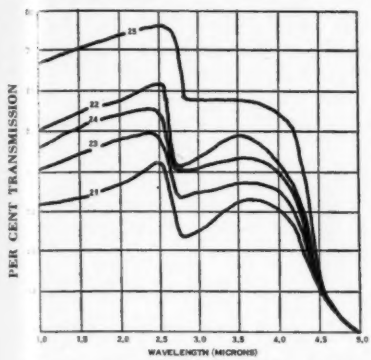

Fig. 4. 21—0.408 CM; 22—0.283 CM; 23—0.283 CM; 24—0.312 CM; 25—0.293 CM.

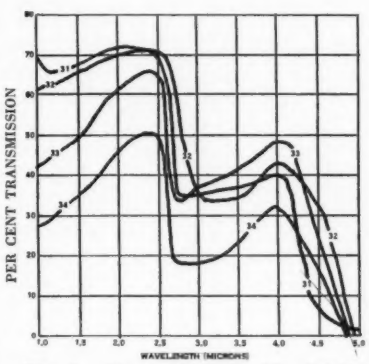

Fig. 5. 31—0.396 CM; 32—0.262 CM; 33—0.241 CM; 34—0.355 CM.

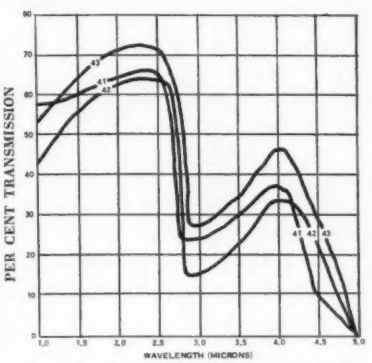

Fig. 6. 41—0.402 CM; 42—0.424 CM; 43—0.259 CM.

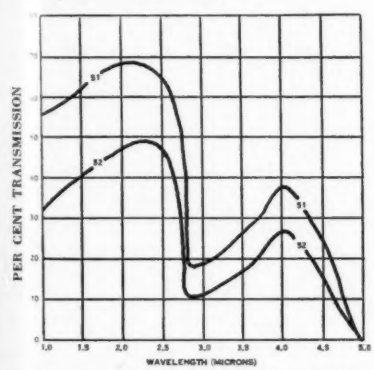

Fig. 7. 51—0.335 CM; 52—0.389 CM.

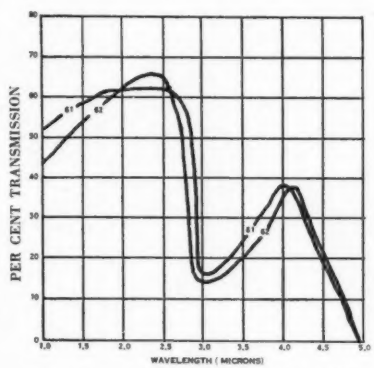

Fig. 8. 61—0.485 CM; 62—0.396 CM.

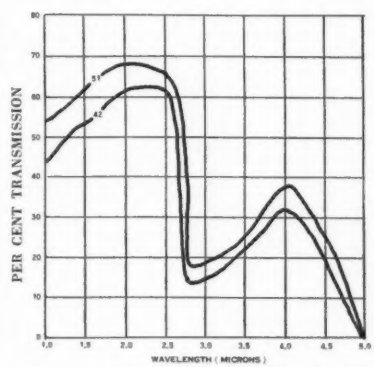

Fig. 9. 42—0.424 CM; 51—0.335 CM.

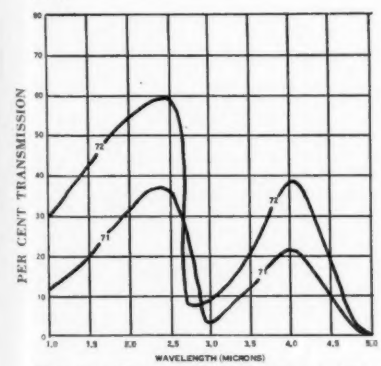

Fig. 10. 71—0.515 CM; 72—0.396 CM.

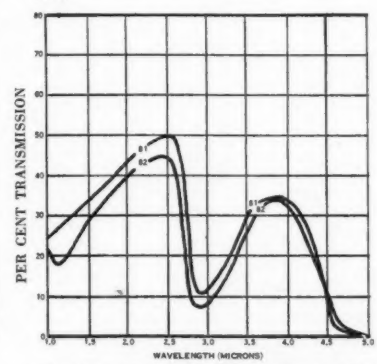

Fig. 11. 81—0.488 CM; 82—0.439 CM.

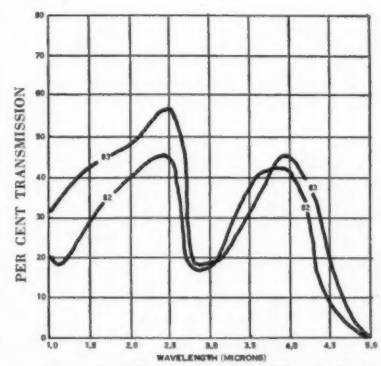

Fig. 12. 82—0.439 CM; 83—0.627.

quenched to room temperature in order to minimize the time in the range of the liquidus temperature. (Some of the glasses devitrified upon cooling, but no attempt was made to either re-make them or to identify their crystalline phases.) The melts were then put back into the furnace and cooled slowly from about 1200°F to room temperature to attain a satisfactory anneal. A one-inch diameter disc about 1/8 inch thick was cut from each crucible. These were ground flat and polished before measurement of their infrared transmission. The area used for transmission measurement was marked on each sample and the thickness was measured at the center of this area.

It was noted (from the formula in any general physics text) that two measurements of transmission of the same materials through two different thicknesses would provide enough data to calculate the absorption coefficient, reflection loss, and index of refraction. It was therefore decided to measure the transmission of the samples and then grind them to smaller thickness and remeasure their transmission.

Those samples which were measured at two thicknesses were re-ground, polished, and submitted again for transmission measurements.

One composition was melted twice separately and samples from each melt measured at two thicknesses to estimate both the melting and measurement accuracy. The results of this check on accuracy are shown in Fig. I. The curves are reasonably close together and the transmission levels are in the reverse order from the thicknesses as would be expected.. Therefore, the accuracy and the effect of thickness may be estimated. The visual effect of this check should be retained for comparison with the results given further on.

In most of the series, the glasses were measured at two thicknesses. The difference (around 10 per cent) was not, however, great enough to provide the desired accuracy in the calculation of other optical properties. It was decided that future measurements should use a 2:1 ratio of thickness.

Some of the most promising of these compositions were then selected for measurement of their infrared transmission at 400°C since peak energy radiation (black body) occurs at approximately 7.7, 6.1, 5.0, and 4.3 microns for temperatures of 100, 200, 300, and 400°C respectively and because temperatures in this range will be encountered and sustained by the surface of an irdome.

Some of the promising compositions were also selected to be re-made and melted in a specially designed high frequency vacuum induction furnace to eliminate the water absorption band at 2.8 microns. No data will be

Table I

Optical Crystals For Infrared Transmission

Compound	Long Wavelength Transmission Limit (in microns)	Solubility In Cold H_2O (g/100 ml.)	Melting Point (Degrees Centigrade)	Maximum Diameter Commercially Available	Comments
NaCl[1, 2, 6, 8]	15	35.7 (0°C)	801	7.5"	Colorless cubic crystal. Hygroscopic. Cleaves and scratches easily.
KBr[1, 2, 6, 8]	27	53.48 (0°C)	730	7.5"	Colorless cubic crystal. Hygroscopic. Soft and easily scratched.
KCl[2]	21	34.7 (20°C)	776	7.5"	Colorless cubic crystal. Hygroscopic. Cleaves and scratches easily.
KI[1,2]	31	127.5 (0°C)	723	7.5"	Colorless cubic crystal. Hygroscopic. Soft cleaves and scratches easily.
AgCl[2, 7, 10]	30	0.000	455	4 "	Colorless cubic crystal; isotropic. Soft and malleable; subject to cold flow. Corrosive to metal. Deteriorates in ultraviolet light.
LiF[1, 2, 6, 8]	5	0.27 (18°C)	870	5 "	Colorless cubic crystal. Cleaves and scratches easily.
CaF_2[2, 8]	9	0.002 (18°C)	1360	6 "	Colorless cubic crystal. Cleaves and scratches easily.
BaF_2[2, 8]	12	0.17 (10°C)	1280	6 "	Colorless cubic crystal.
CsBr[2]	40	124.3 (25°C)	636	1.75"	Colorless cubic crystal. Hygroscopic. Soft, easily scratched.
CsI[2, 4]	50	44. (0°C)	621	5.5"	Colorless cubic crystal.
Al_2O_3[3, 8]	5.5	0.000	2050	2.5"	Hexagonal crystal. No cleavage. Does not scratch readily. Excellent mechanical strength and good thermal properties.
Si[5]	20	0.000	1420	1.5"	Steel-grey cubic crystal. Transmission decreases above 300°C.
Ge	16	0.000	958.5	....	Metallic grey-white cubic crystal.
MgO[3] (Periclase)	5.5	0.00062	2500-800	....	Colorless cubic crystal. Good thermal properties. Not readily scratched.
KRS-5[2]	40	0.02 (0°C)	....	5 "	Red cubic crystal. No cleavage. Strains easily. High thermal expansion. Toxic.
KRS-6[9]	30	0.1 (0°C)	....	7.5'	Colorless cubic crystal. Toxic.

presented on the induction melted glasses. It can be reported, however, that in spite of problems of reduction and dissociation encountered in vacuum melting, the CO_2 and water absorption bands may be eliminated by this technique.

The vacuum induction melting apparatus and procedures used with it will be described in a paper now in preparation. Another future paper will describe transmission characteristics of glasses melted with this equipment.

Results and Conclusions

Of several hundred glasses prepared, only a few typical compositions are presented. In the figures, reader's attention is directed mainly to the general level of transmission, ignoring the CO_2 and H_2O absorption bands, since there is good prospect of eliminating them, and to the wavelength where decrease in transmission is most apparent. Consideration was given to the thicknesses noted on each figure. The conclusions stated for each series of glasses are mainly deductive because of thickness differences. Although thickness correction can be calculated, the procedure is both laborious and inaccurate and therefore the transmission curves of the compositions shown are those from which the more obvious conclusions may be drawn.

Table III shows the calculated oxide composition in weight per cent for each glass reported.

Figure 2 shows the effect of replacing all of the arsenic oxide with alumina in a barium-lanthanum-tellurate glass. Composition *01* contains As_2O_3, *02* alumina. Little change results which cannot be attributed to the difference in thickness. Figure 3 shows the effect of replacing part of the titania with additional silica in a barium-titanate glass. As the composition changes from 11 to 14, silica is increased at the expense of titania. Improved transmission results. Figure 4 further demonstrates the effect of replacing titania with silica at a higher level of baria in a barium titanate glass. As the composition changes from 21 to 25 titania is replaced by silica. Improved transmission is evident.

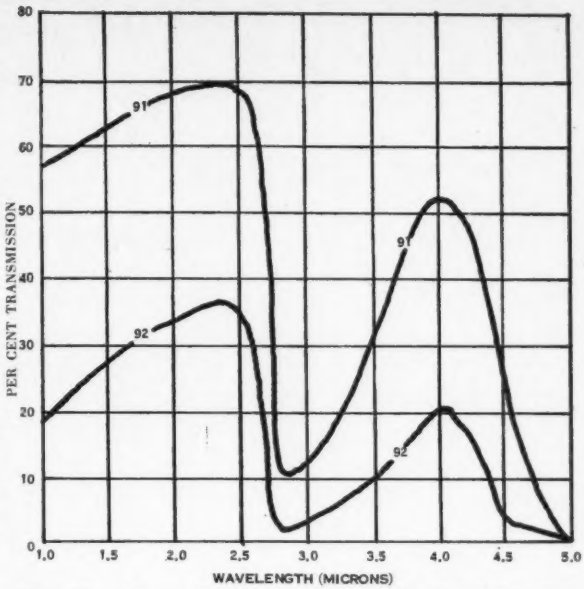

Fig. 13. Composition: 91—0.384 CM; 92—0.693 CM.

Figures 5 - 8 demonstrate the effects of the soda-silica ratio in the presence of different baria-calcia-alumina ratios. Figure 5 shows the effect of replacing soda with silica in a barium-calcium-aluminate glass. Composition 34 contains no silica, 31 no soda. Increased transmission results. Figure 6 again shows the effect of replacing soda with silica with the same baria-calcia-alumina ratio but with a lower total soda plus silica. As the composition goes from 43 to 41 silica is replaced by all soda. Un-

(*Continued on page* 212)

Table II

Glasses For Infrared Transmission

Major Constituent	Modifiers	Transmission Range	Sample Thickness	Per cent transmission at 2mu	3mu	4mu	5mu	6mu	Remarks
SiO_2[11, 12, 13, 14]	Na_2O, CaO Al_2O_3, BaO, ZnO, TiO_2, CoO, MnO_2, Cr_2O_3, Sb_2O_3, Se, CdS	Visible to 6 mu	1 mm	90	65 -80	78 -88	16 -57	0 -16	Wide variation in properties attainable by selecting proper compositions.
Al_2O_3 [15]	CaO, BaO	to 6 mu	1 mm	90	50	80	70	18	
GeO_2 [15, 16]	PbO, ZrO_2 Al_2O_3, La_2O_3, Li_2O, MnO_2	to 6 mu; little or no visible	2 mm	80	70	75	60 75	20-35 10	H_2O absorption band reduced by dry air treatment.
Sb_2O_3 [17]	Al_2O_3, Na_2O, K_2O	to 6.2 mu	3.1	60		60			H_2O absorption band at 3 microns.
TeO_2 [18, 19, 20]	WO_2	to 6 mu	1 mm	72	54	65	60	0	Deformation temperature: 330 to 380°C.
	MoO_3	to 6 mu	1 mm	75	40	62	50	0	Constituents melt at 900°C.
	Al $(OH)_3$, BaF_2, La_2O_3, As_2O_5	to 6 mu	3 mm	88			75	0	Constituents melt at 2000°F.
V_2O_5 [21]	TeO_2, BaO, PbO, P_2O_5, CaO	2 to 5 mu; opaque to visible							
As_2S_3 [22, 23, 24]	As_2 Se_3, As_2 Te_3	to 12 mu; little or no visible	2 mm	more than 70					Softens below 200°C.
Se [25]	Te	to 21 mu; little or no visible	2 mm 14.5 mm	between 60 and 70% to 21 microns 50% between 1 and 12 mu					Low softening temperature.

The Care of Platinum Thermocouples

BY H. E. BENNETT

• THE PLATINUM THERMOCOUPLE is probably the most accurate and convenient method now available for the measurement of high-temperature in industrial processes. Provided that the correct conditions of use are properly understood, the platinum thermocouple with auxiliary equipment is a robust and reliable industrial instrument.

Because of its small size and low thermal capacity, the couple can be introduced directly to the point at which measurement is to be made, and will respond immediately to temperature changes. The protective sheath can be small and inexpensive, and by the use of compensating leads it is easy to take the indicating point well away from the measuring point, which is often hot and dirty.

Because of their nobility, platinum and its alloys will withstand much more adverse conditions than will base metal thermocouples, but they none the less have limitations. The melting point of platinum is 1769°C and that of its highest melting rhodium alloy useful for thermocouple purposes is about 1890°C. This is therefore the absolute limit of temperature that a platinum alloy couple will measure, and then only for a short time.

In immersion pyrometry for measuring the temperature of molten steel, platinum alloy couples—in conjunction with a quick-response indicator—can be used momentarily at temperatures approaching these high values. For many other purposes thermocouples must be kept at temperature for long periods of time, and caution must then be observed if the couple is to have a reasonable life. Grain growth, which occurs particularly in pure platinum when couples are kept at temperatures around 1500 to 1600°C, need not be deleterious provided that the wire is not under any appreciable stress and that it is kept free from contamination, but these conditions are not particularly easy to obtain.

Effect of Prolonged Heating

The harmful effect of prolonged heating at high temperature is the migration of the alloying constituent from one wire to the other. The platinum element of the platinum: rhodium-platinum couple tends to pick up rhodium, and as it does so the e.m.f. at any given temperature becomes progressively less. If the platinum wire is protected by a refractory insulator the pick-up of rhodium is minimized.

It is difficult to give a definite figure for the expected useful life of a thermocouple as so much depends upon particular conditions. Instances have been recorded of platinum: rhodium-platinum couples being in use continuously for three years at about 1300°C with a loss in e.m.f. equivalent to only a few degrees. Obviously the higher the temperature of operation the greater the migration of rhodium and consequently the more rapid the change in calibration.

Increase in e.m.f. at 1200°C against Pure Platinum by Addition of 0.01 Per Cent Rhodium

	Microvolts
Platinum	150
1 per cent rhodium	20
5 " "	11
10 " "	6
13 " "	4

It can be seen in the table that a small pick-up of rhodium does not have such a great effect on a rhodium-platinum alloy as it does on pure platinum. For this reason a 1 per cent rhodium-platinum: 13 per cent rhodium-platinum thermocouple can be used where it is important that changes in calibration shall be kept to a minimum over long periods. In practice, however it is usually found that the thermocouple has deteriorated by contamination from other sources before the calibration has changed significantly.

Contamination by Metallic Vapors

Metallic vapors of lead, zinc and bismuth are among the commoner contaminants which readily alloy with

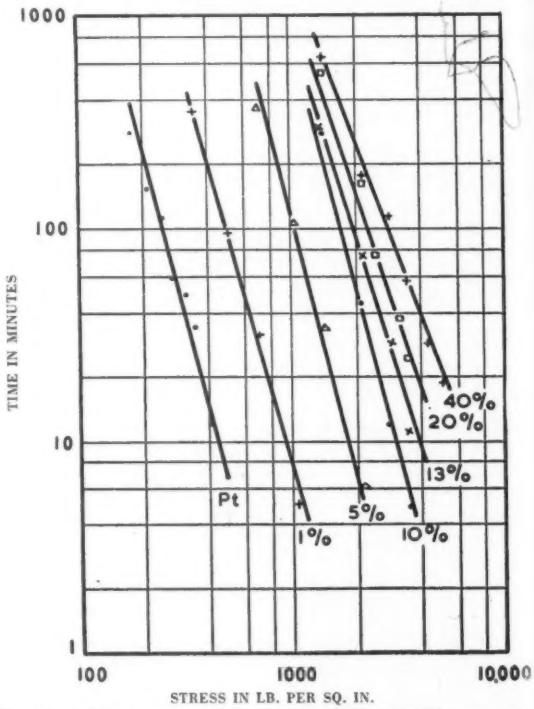

Fig. 1. Stress-to-rupture test on rhodium-platinum alloys at 1400°C.

Reprinted from "Platinum Metals Review," a quarterly publication available from J. Bishop & Co., Malvern, Penna., and published by Johnson, Mathey & Co., Ltd., London, England.

platinum to form brittle intercrystalline constituents and so to cause premature failure of thermocouples. The presence of these impurities is often quite unsuspected, but they can arise from solders, galvanized iron, brass, or molten glass that may be present in the furnace, and couples need to be protected against them.

The couple wires must be insulated from each other and the use of a double-bore refractory tube is to be recommended so that both wires are confined. This assembly should be placed in a closed refractory sheath capable of withstanding the required temperature, as well as temperature changes and the furnace atmosphere. Silica may be used continuously at temperatures up to about 1000°C but for higher temperatures fireclay, graphite, silico carbide mixtures or aluminous porcelain may be used. Fused alumina refractories are excellent for use in a hydrogen or other reducing atmosphere, in which platinum will be contaminated by any material containing silica, but they are not resistant to thermal shock and they must be heated and cooled very slowly to prevent cracking. Sometimes for added protection it is advisable to place the refractory sheath inside a metal sheath.

Embrittlement Due to Oil or Grease

The couple, the insulators and the inside of the sheath assembly must always be kept clean and free from oil or grease. Most refractories contain some silica, and it has been proved that in a reducing carbonaceous atmosphere the presence of sulphur (frequently present in oil) causes a complex reaction resulting in some reduction of the silica to silicon, which then alloys with the platinum to form a brittle grain boundary constituent. For this reason, thin leather gloves are frequently worn when handling thermocouples to prevent contamination by oil or grease. It cannot be emphasized too strongly that to obtain good service from platinum thermocouples, cleanliness and adequate protection from contamination must be taken seriously.

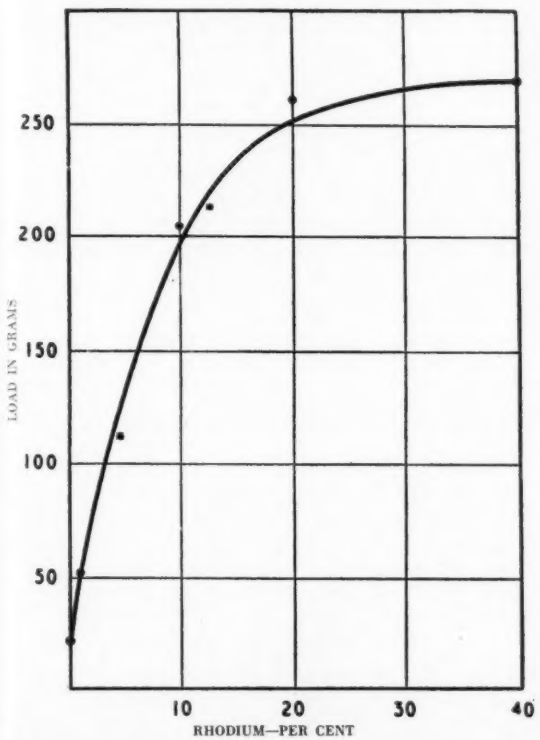

Fig. 2. Load-to-rupture in 250 minutes for rhodium-platinum alloy wires.

Tensile Stresses

A platinum thermocouple should also be as free from stress as possible. The table shows the hardness and

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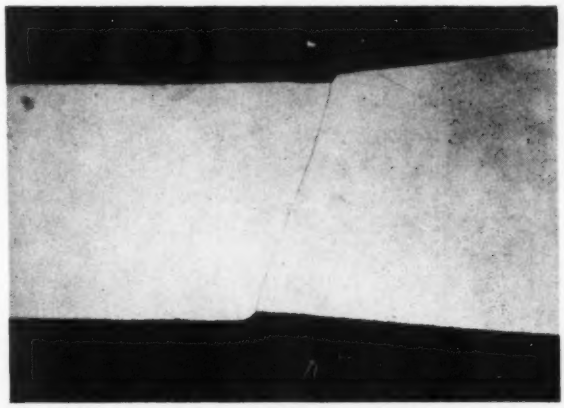


Fig. 3. Section of pure platinum wire after stressing at 1400°C, showing sliding at grain boundary. X 120

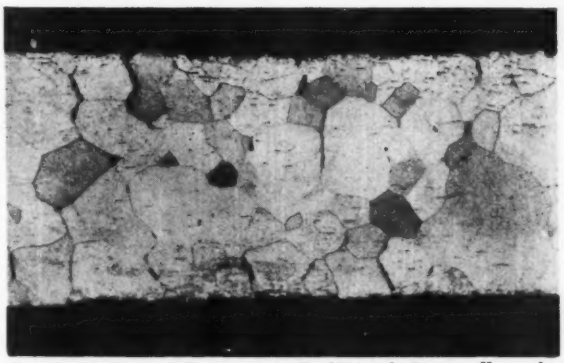


Fig. 4. Section of 5 per cent rhodium-platinum alloy wire after prolonged stressing at 1400°C. X 120

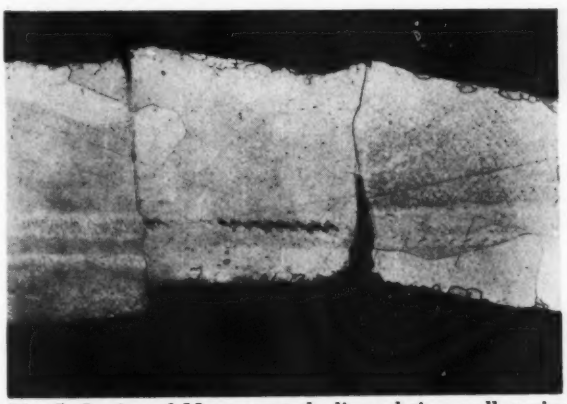


Fig. 5. Section of 13 per cent rhodium-platinum alloy wire after failure in service. X 120

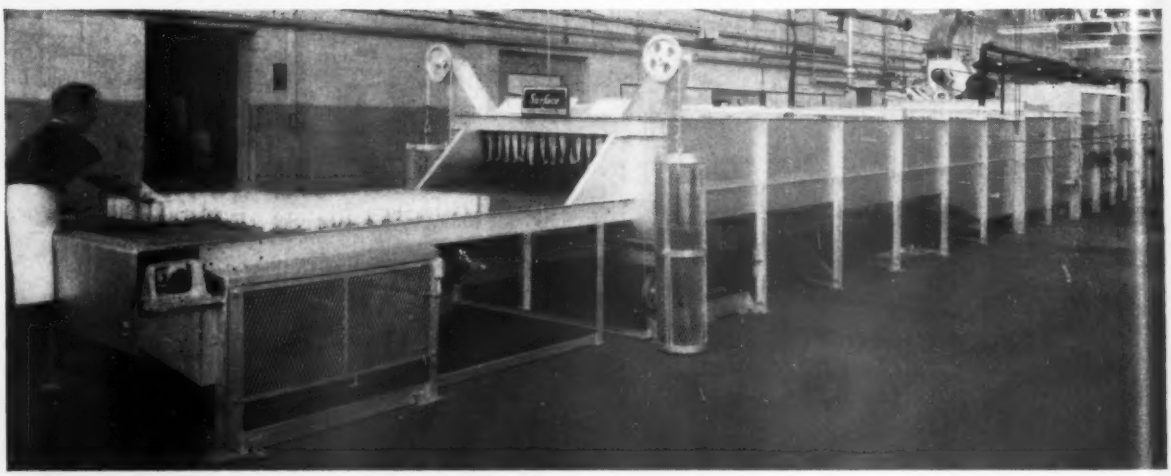
a "useful life" can cost you money

Depreciation policies based on the useful physical life of equipment have lulled many companies into dangerous complacency. By ignoring inflation and technological obsolescence, they pay dividends and taxes on profits which don't really exist.

Inevitably, they discover that their depreciation reserves are inadequate to replace worn out or obsolete equipment.

However, aggressive managements have found two alternatives to that dilemma. First, they prove to the Government that their depreciation rates should be based on the economic—not the physical—life of their equipment.

Second, they purchase equipment which will recoup their investment within its economic lifetime. This is the factor which prompts many companies to specify Surface Combustion lehrs, kilns, and ovens.



This radiant tube decorating lehr is recouping its owner's investment.

Surface Combustion Corporation

2378 Dorr Street, Toledo 1, Ohio. In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ont.

wherever heat is used in industry

Surface

BROCKWAY-TYGART VALLEY

The directors of Brockway Glass Company and Tygart Valley Glass Company, respectively, have agreed on a statutory merger which would make Tygart a wholly owned subsidiary of Brockway. The new agreement, according to Glenn A. Mengle, chairman, and Finley B. Hess, president, of Brockway, and O. C. Noble, Tygart Valley president, is effective pending a ruling by the U. S. Treasury Department and a vote of approval by the stockholders.

Glenn A. Mengle

O. C. Noble

Finley B. Hess

This merger will be advantageous to each company and will result in a corporate structure with more than $26 million of assets and approximately 3000 employees.

Combined net sales of the two companies in 1958 were about $46 million, and income was $2½ million. Plants of the combined companies are in Brockway and Crenshaw, Penna.; Freehold, N. J.; Muskogee, Oklahoma; Lapel, Ind.; and the Tygart plant in Washington, Penna. The Demuth Glass Works, Inc., Parkersburg, West Virginia, is a wholly owned subsidiary of Brockway.

Under the merger agreement, Tygart management will remain unchanged for approximately 3 years; the only contemplated change in personnel is the addition of a Tygart representative to the Brockway board of directors.

The treasury Department is expected to rule shortly that this merger is tax free. At that time, the directors will call a stockholders meeting for a vote to approve the proposed merger. Ownership transfer has been negotiated on a stock dollar for dollar arrangement, with no additional cash amount involved. Common and Preferred stocks will be exchanged in proportion to the ratio held by Brockway Stockholders.

The merger is expected to speed up Tygart's most recent expansion program, begun in 1954, by providing the company with facilities needed for additional variety in the firm's product line. The company will also have greatly expanded engineering and research facilities.

Brockway will benefit from the merger by being able to expand into new product lines.

"By efficient use of the facilities of both firms," Mr. Hess explained, "we can achieve greater depth, broaden our market potential through the introduction of additional colors in glass, and we can achieve a better balanced service condition."

The combined sales volume of the two companies will make Brockway the fourth largest glass container manufacturer in the United States.

Brockway was founded in 1907. Principal market is east of the Rockies; an export division handles all foreign trade. Plants in five strategic locations provide a wide range of containers and glassware.

Tygart Valley was founded in 1895 as Beaumont Glass, West Virginia. The present name was assumed in 1906 with offices and plants in Washington, Pennsylvania. Principal markets include the states east of the Mississippi and north of the Carolinas. The company supplies glass containers primarily to the food industry but maintains secondary markets throughout their sales area.

MEXICO REF. AND KAISER ALUMINUM

Kaiser Aluminum & Chemical Corporation and Mexico Refractories Company have reached agreement on the terms of a merger in which, subject to ratification by the stockholders of both companies, Mexico Refractories will operate as a division of Kaiser. It will function along with the Kaiser chemicals division, in the production and sales of refractory products for high temperature industrial application.

Under the agreement, stockholders of Mexico Refractories will receive 300,000 shares of Kaiser Aluminum common stock and 150,000 shares of a new series of $100 par value 4¾ per cent convertible preference stock. One share of the preference stock is convertible initially into two shares of common. Mexico Refractories has 861,865 shares of common stock outstanding.

The combined operations, according to D. A. Rhoades, vice president and general manager of Kaiser Aluminum, and J. B. Arthur, board chairman of Mexico Refractories, will place the corporation among the country's most diversified refractory producers, with 9 plants and 27 sales offices.

Refractory products of both companies compliment each other. Kaiser chemicals division supplies basic refractories, made primarily from magnesia grains, to the glass, steel, cement and copper industries. Mexico Refractories supplies fire clay, silica and alumina refractoires and a wide variety of specialty products to the same industries, as well as to others.

Mexico Refractories began operating at Mexico, Missouri, in 1930 and has expanded several times, acquiring plant at Van Dyke, Penna.; Frostburg, Md.; and Niles, Ohio. It also operates a Canadian plant under the name of Refractories Engineering & Supplies Limited at Bronte, Ontario.

Kaiser Chemicals division entered basic refractories over 15 years ago and is an integrated operation with three plants in the Salinas-Moss Landing area in California, and a basic refractory plant at Columbiana, Ohio, which was constructed about three years ago.

Dr. Marvin G. Britton

Karl K. Breit

BRITTON HEADS CORNING DIVISION

Dr. Marvin G. Britton has been appointed development manager of the new products division, Corning Glass Works. During his nine years with the company he has worked primarily in the field of refractory development, most recently with the ceramic research department as a senior research associate.

BOSCHIN WITH ANCHOR HOCKING

Walter E. Boschin has been appointed to the glass manufacturing operations staff of Anchor Hocking Glass Corporation, with headquarters at San Leandro, California. The company has a new glass plant under construction here, and Mr. Boschin's immediate assignment is to supervise the construction, including installation of necessary machinery and equipment.

He has been in the glass container industry for 39 years, having held responsible positions with Pacific Coast Glass Company, Owens-Illinois Glass Company, and Thatcher Glass Manufacturing Company, among others.

NEW PERISCOPE MADE BY AMER. OPTICAL

American Optical Company has developed a new periscope for tanks and jet planes as a replacement for the conventional windshield. It is one inch high and has cylindrical lenses instead of the usual spherical ones.

Dr. Lewis Hyde of American Optical, and inventor of the periscopes, described his inventions in a paper before the Optical Society of America early this month. He pointed out that the periscopes overcome the adverse conditions encountered by ordinary windshields in supersonic planes.

The small periscopes do not create wind resistance, and they are able to withstand the intense heat created at high speeds, unlike windshields made of ordinary glass.

By using the tank periscope, the driver is able to see the road ahead without exposing himself to enemy fire, and the large field of vision allows him to sit comfortably in his seat with freedom to move his head easily and watch his instruments.

The periscopes were developed at the company's research center in Southbridge, Mass., and were built at the instrument division, Buffalo, N.Y., and at J. W. Fecker, Inc., Pittsburgh, American Optical's wholly-owned subsidiary.

BREIT WITH REMMEY

Karl K. Breit has been appointed chief sales engineer of Richard C. Remmey Son Company, subsidiary of A. P. Green Fire Brick Company. He had previously been with A. P. Green and for the past few years has been concentrating on refractory problems and applications involving many of the products manufactured by Remmey.

FLEXON, GEN. MANAGER, O-I PLANT

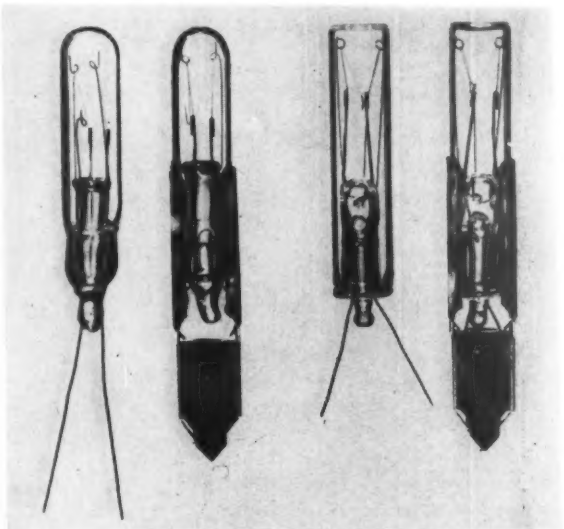
Floyd Flexon has been named general manager of the new Owens-Illinois plant at Bogota, Colombia, which will employ some 200 Colombians. He will depart for South America after he has chosen a small number of Owens-Illinois people to help him in training the Colombian personnel.

Mr. Flexon was formerly assistant to the general factories manager of the glass container division in Toledo, a position he has held since 1957. Prior to that, he was for 25 years manager of the company's Alton, Ill., plant. Altogether, he has had 41 years of experience in the glass container manufacturing field.

Located on a 35-acre tract of land 10 miles south of Bogota, the new Owens-Illinois plant will begin glass container production late this year or early in 1960.

INVITATION TO VISIT WALSH PLANT

Walsh Refractories Corporation has extended an invitation to American Ceramic Society members attending the annual meeting in May to visit their new factory for the manufacture of FC-101, premium fusion cast refractory. Although production will not be at full capacity, according to J. J. Duggan, vice president and sales manager of the glass refractories division, there will still be many interesting things to see. It is located at 101 Ferry St., St. Louis 7, Mo.



New line of flat-top telephone switchboard light bulbs introduced by Sylvania Lighting Products, division of Sylvania Electric Products Inc. Filament can be placed closer to end of flat-top bulbs than to top of customary bulbs (left), which, the company states, produces a 40 to 60 per cent increase in end footcandles. New straight side wall construction provides twice the area for cementing glass jacket to side contacts.

OWENS-ILLINOIS GLASS COMPANY

Total sales in 1958: $508,459,930; in 1957: $510,486,850.

Net earnings: $37,772,005 (1958), or $4.82 per common share, after preferred dividend requirements. Net earnings in 1957: $35,810,017, or $4.55 per common share, after preferred requirements.

Although earnings in 1958 were higher than those of 1957, sales dropped slightly because of the sale of assets of the company's Kaylo division, as well as "adverse market conditions, especially during the first six months, in the containerboard and corrugated box segments of the business."

A large portion of the company's capital expenditures last year were made in foreign investments. Of a total expenditure of $23,748,300 for additions and replacements, $5.526,700 was expended outside the United States.

Glass container factories in Cuba and Venezuela began operations during the last half of the year, while a third Latin American facility, near Bogota, Colombia, is expected to become operational in the latter part of 1959.

An important addition to domestic facilites was a machine shop at Godfrey, Ill., to manufacture machines and machine parts for the company's own use. This operation was moved from the Alton, Ill., plant to permit mold manufacturing shops to be expanded at that location.

Owens-Illinois decreased expenditures for research, development and engineering slightly during 1958, compared with 1957, primarily because of a shift in emphasis in certain electronic glass developments.

The Annual Report states that much of the basic research on glass was directed toward developing new types of glass for use in the electronics field. Some of this effort concerned compositions having resistance to high-temperatures and to bombardment by high energy particles. Additional research concerned composites of glass, ceramics and metals.

PITTSBURGH PLATE GLASS COMPANY

Total sales in 1958: $513,649,000, a decline of 17 per cent from the 1957 figure of $620,803,000.

Net profit: $32,076,000, or $3.24 per share (1958). Net profit in 1957: $57,963,000, or $5.86 per share.

The substantial reduction in earnings, the report states, resulted principally from decreased sales volume. Increased research and advertising programs and increased depreciation resulting from expanded and improved facilities had the effect of further reducing earnings. These programs are an important part of the company's plan for growth in future years.

Pittsburgh Plate's 75th anniversary year (1957-1958) was affected by a long strike in the Glass division, the first in 13 years, and longest in its history, which idled 13,000 glass workers in all glass manufacturing and fabricating plants. The strike, however, did not affect 1958 earnings as much as its duration might lead one to believe, largely because PPG produced in advance a large portion of fourth-quarter requirements.

New plants: The Pennvernon window glass plant at Decatur, Illinois, is scheduled for completion this month, and the Crestline, Ohio plant for the fabrication of tempered automobile safety glass will be ready within the year.

A fiber glass yarn plant began partial production at Shelby, N.C. on April 1, and Columbia-Southern completed its Bartlett, Calif., soda ash plant in December.

Pittsburgh Plate Glass International S.A., a Swiss corporation and a new wholly-owned subsidiary, was established in 1958. Headquarters of International is at Geneva, and an important branch, now fully staffed, is beginning operations at Havana, Cuba.

International, under the leadership of its first president, Dwight R. Means, is looking forward to the possibility of producing abroad some of the products made by the parent company in the United States.

The continuing trend to glass-clad buildings, the Report continues, provides increasing markets for the sale of Spandrelite enameled structural glass, Pittco store front metal and plate glass, including heavy plate and the specially tinted glasses such as Solex heat-absorbing glass and Solargray neutral gray plate glass.

The increased interest of architects in neutral gray glasses to protect against glare enabled PPG's new "Graylite" neutral grey sheet glass, introduced last spring, to find a ready market.

LIBBEY-OWENS-FORD GLASS CO.

Total sales in 1958: $216,900,913, or approximately 8.6 per cent below the 1957 total of $237,199,067.

Net profit, after taxes: $21,445,309 (1958), or 23.4 per cent lower than the 1957 net profit of $28,005,489. Earnings per share: $4.10 in 1958; $5.36 in 1957.

Capital expenditures for 1958 amounted to $14,616,029, bringing the amount invested in new plants, facilities and machinery in the last five years to $104,733,582.

Outstanding technical and production achievements of the company were the development of larger laminated windshields with compound curvatures, shaded backlights, and improved Thermopane insulating glass.

The larger sizes of automotive glass have brought about important changes in packaging and warehousing of replacement glass parts. The company completed a new warehouse in 1958 for handling replacement auto glass at the Toledo factory. Millions of square feet of more than 500 different automotive safety glass parts are normally stocked.

Modern methods of using glass for exterior curtain walls in large buildings employ several L-O-F products, including Thermopane insulating glass, Vitrolux spandrel glass (for insulation, maximum daylight and color), and Parallel-O-Grey and heat-absorbing plate glass for controlling solar heat and reducing glare.

Late last year Johns-Manville Corporation made a proposal for one of its subsidiaries to acquire LOF Glass Fibers Company by exchange of stock in a ratio of one share of Johns-Manville common for each 2½ shares of Glass Fibers common. Libbey-Owens-Ford had owned slightly more than 50 per cent of the LOF Glass Fibers stock, with a total investment of $11,847,327.

After approval of the stockholders, L-O-F acquired 553,825 shares of Johns-Manville common stock having a market value of $29,075,812 at the end of the year. L-O-F therefore plans to participate in the earnings not

only of the fiber glass business but also of other related industrial insulation and building materials business of Johns-Manville.

AMERICAN-SAINT GOBAIN CORPORATION

American-Saint Gobain Corporation last month issued its first Annual Report. On May 26, 1958, American Window Glass Company and Blue Ridge Glass Corporation were merged into and with American-Saint Gobain, following approval of shareholders of both companies and the necessary agencies of the French and United States Governments.

The report covers the full year's operations of both companies.

Net sales (1958): $24,764,897, showing a loss of $276,468—after tax loss carry-back—compared with sales for 1957 of $25,620,948 and a profit of $203,070, after taxes.

Since the merger, American-Saint Gobain has continued its efforts to develop a satisfactory financing program to permit the construction of the planned plate glass factory. Additional studies of plant sites for the proposed plant are being made, and selected location will be made after the financing program has been completed and approved.

Net working capital: $5,111,370 (1958), as compared with $4,795,095 in 1957, or a decrease of $683,725. This decrease resulted primarily from the expenditures required for the modification of the glass drawing facilities and the repair of the large clear glass furnace at the Arnold, Penna., plant.

Operations in the rolled glass division improved during the year. New production equipment installed in Kingsport in late 1957 for the manufacture of wired glass has substantially improved operating results for this wired glass.

Huetex, used for spandrels in modern commercial buildings, and made in a variety of colors, is growing in popularity.

In research and development, according to the report, American-Saint Gobain has continued its work on melting techniques of glass, as well as on the improvement of machinery and equipment used in the manufacture of flat glass products. After the merger, greater resources and facilities became available for these programs, and the company is now planning to integrate and expand its research activities in order to develop new products and equipment.

Arsenic trisulfide lens blank, 18 inches in diameter and one inch thick, made by the Glass Laboratory of American Optical Company. Twenty-five pounds in weight, these blanks are said to be the largest that have been made in this infrared-transmitting material.

CRAWFORD APPOINTED BY CORNING

Clark A. Crawford has been appointed manager of product planning for Corning Glass Works. He will be responsible for coordinating development programs with product line divisions and research, development, engineering and market research groups.

Having joined the company's research laboratories in 1944, Mr. Crawford was named quality and process engineer of "A" Factory in 1951, where he became production superintendent in 1952. In 1954 he was appointed plant manager of the company's Central Falls, R.I., plant and returned to Corning the following year as manager of the Pressware plant.

O-I TO BUILD 17th CONTAINER PLANT

Owens-Illinois has announced plans for the construction of a multifurnace glass container plant on a 24-acre site on the Inner Harbor Industrial Canal in New Orleans. This plant, the company's 17th for the manufacture of bottles and jars, will occupy about 150,000 square feet, leaving plenty of room for expansion. The land has been leased from the board of commissioners of the Port of New Orleans for 99 years.

One of the features of the new plant will be a fully automatic batch house where raw materials will be mixed and fed to the furnaces.

This expansion, together with the construction of other Owens-Illinois plants in the past several years, said J. P. Levis, chairman of the board, reflects the company's confidence in the future of glass containers.

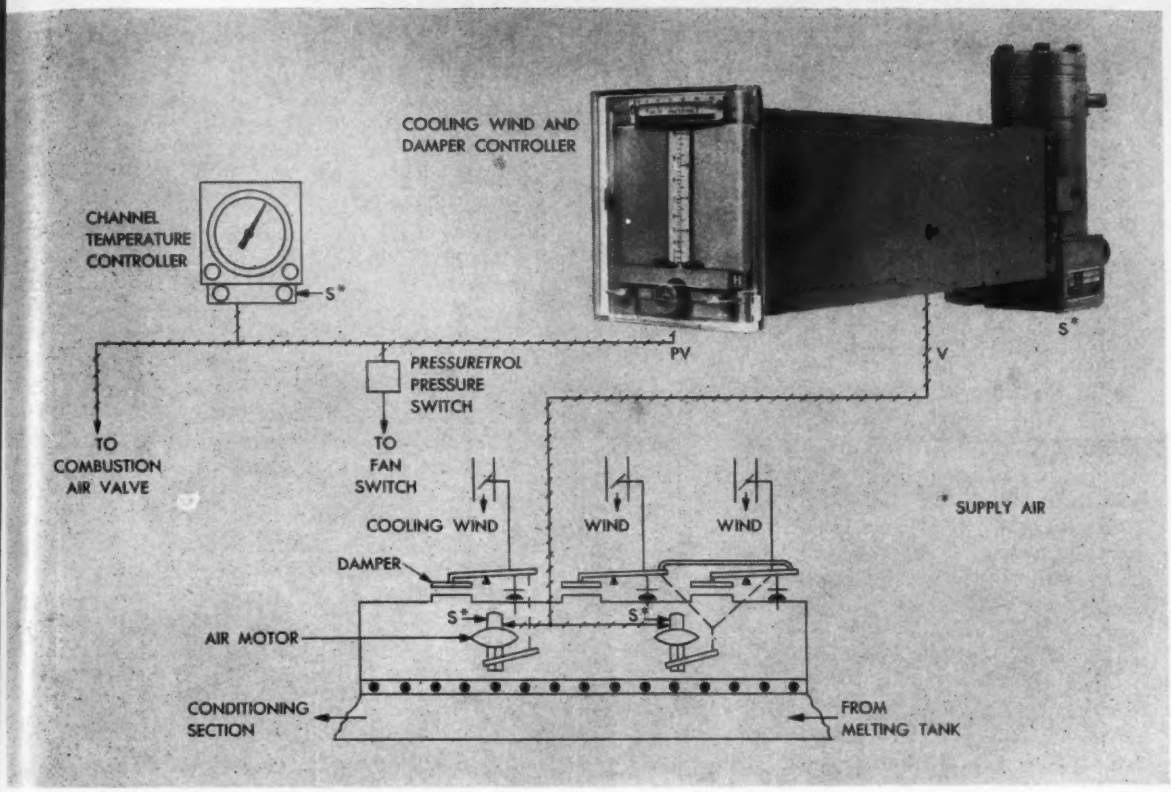
Shipments of glass containers, he continued, should exceed 45 billion units by 1975, and 45 per cent of the increase will result from new developments and uses, with the remainder brought about by increases in population and buying power.

CORNING ANNOUNCES NEW CAPACITOR

Corning Glass Works has developed a new fusion-sealed capacitor at its Bradford, Penna., electronic components department. It is fused around the edge and at the juncture of lead and capacitor body by new sealing techniques which make it impervious to moisture.

It is guaranteed to show no significant change in capacitance or increase in dielectric loss after more than 1,000 hours in a high-humidity atmosphere, and, in a demonstration test, they have withstood more than 500 hours in a boiling, saline solution with negligible change in performance.

A new, high-temperature sealing method provides a moisture-proof seal around the edge of the capacitor, states Allen W. Dawson, manager of the Bradford plant, and a specially developed copper-clad, nickel-iron lead gives true glass-to-metal seal between the lead and capacitor body.



Ball Bros. Co. saves fuel, improves ware with *Tel-O-Set** cooling wind controls

Tel-O-Set controller added to forehearth heat control system to regulate cooling wind at Hillsboro, Ill. plant.

Ball Brothers Company, home office Muncie, Ind., manufacturer of narrow and wide mouth flint and amber glass containers, gains major savings with Honeywell's new system for interlocking burner and cooling wind controls. With accurate, automatic control of all forehearth variables, Ball Brothers gets these advantages:

- More uniform glass temperature in the forehearth
- Faster recovery and stabilization of glass temperature after a job change
- Freedom for machine operators to perform other duties
- Less fuel consumption
- Increased production

The *Tel-O-Set* controller was installed to receive its basic control signal from an existing pneumatic temperature controller. It operates air motors which precisely adjust cooling wind dampers, flues and butterfly valves. This new combination of instruments continuously readjusts heating and cooling wind, maintaining the desired heat to prevent overcooling the glass near the channel sides.

When the limits of the cooling wind adjustment have been reached, heating control continues to change the fuel supply to maintain desired glass temperature. The *Tel-O-Set* controller permits manual cooling wind operation from the panel during startup. After startup, control can be transferred bumplessly to automatic operation.

Get complete details on how to apply *Tel-O-Set* controllers and other instruments to your own processes. Call your nearby Honeywell field engineer today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Control

*Trademark

Inventions and Inventors

Feeding and Forming

Process for making stems. Patent No. 2,817,927. Filed March 16, 1956. Issued December 31, 1957. No sheets of drawings; none reproduced. Assigned to Sylvania Electric Products, Inc., by Clayton R. Cowley.

This invention relates to processes for making stems such as those which are designed to become the bases of electron tubes.

In the process of electron tube manufacture, a tubulation integral with the electron tube envelope is held in a suction port and it acts as a conduit for the gas being evacuated from the electron tube. Toward the end of the evacuating process, the tubulation is softened at a point close to the electron tube envelope and while so softened the tubulation is drawn away from the envelope and slightly twisted to seal off the envelope and, incidentally, the softened end of the tubulation. The so-drawn-off tubulation is considered a waste product.

The waste pieces of slender glass tubulation are used and formed into a gob of glass by depositing the gob in the center of a mold having a removable circular array of lead in conductors extending therefrom, and pressing the gob of glass to form a wafer with the lead in conductors embedded in the glass. The waste pieces of glass are of substantially the same length and slender so that small variation in length results in very little difference in weight of glass.

In carrying out the process, an indexible turret type machine may be employed. However, with this invention much fewer working stations than normally employed are requisite to convert the glass tubulation into the pressed stem.

There were 6 claims and the following references cited in this patent.

United States Patents

2,030,185, Rose, Feb. 11, 1936; 2,359,798, Schumann, Oct. 10, 1944; 2,442,860, Richardson, June 8, 1948; and 2,552,381, Porter, May 8, 1951.

Glass feeder shears provided with charge turning mechanism. Patent No. 2,812,619. Filed April 5, 1954. Issued November 12, 1957. One sheet of drawings; none reproduced. Assigned to Emhart Manufacturing Company by Frederick J. Wythe.

This invention relates generally to improvements in glass feeder shears for cutting off charges from successive columns or masses of molten glass in suspension from the glass discharge outlet of a feeder.

Glass feeder shears generally are provided with charge guiding means arranged to contact each severed charge of molten glass at the time of its severance at the side of the charge opposite the lower shear blade so as to keep the charge substantially vertical as it falls from the shearing plane downwardly toward a mold or other charge receiver.

It is desirable, however, in the production of certain glass articles, particularly television face plates and other relatively flat articles, to deliver the glass charges therefore to their molds so that each such charge will land on its side in its mold cavity or at least will be inclined from the horizontal less than from the vertical so that it quickly will assume a horizontal position on the bottom of its mold cavity after the first contact therewith of any portion of the charge.

The object of this invention is to provide a charge side contact member associated with and positioned close beneath the lower blade of glass feeder shears and operable on each cutting stroke of the shear blades to contact the side of the upper end portion of the severed charge so as to impart a relatively large turning moment to the charge at the instant of its severance, the side contact member being movable with the lower shear blade and also relatively thereto so as to be moving in the direction of the longitudinal axis of the charge at a relatively high velocity at the instant of cutting when the associate shear blade approaches zero velocity.

There were 7 claims and the following references cited in this patent.

United States Patents

1,926,823, Stewart, Sept. 12, 1933; 1,999,444, Curtis, Apr. 30, 1935; 2,179,317, Barnard, Nov. 7, 1939; 2,208,868, Wadsworth, June 25, 1940; 2,678,518, Honiss, May 18, 1954; and 2,681,530, Peiler, June 22, 1954.

Furnaces

Glass furnace. Patent No. 2,845,750. Filed March 9, 1955. Issued August 5, 1958. No sheets of drawings; none reproduced. Assigned to ———— by Harvey L. Penberthy.

This invention relates to glass furnaces and more particularly relates to a means and method for cooling the walls of glass furnaces.

It is proposed to carry out a more efficient cooling of the furnace walls without the expenditure of any separately purchased energy. The walls of a glass furnace are provided with long hollow boilers running therealong in proximity thereto, in a position to absorb radiant heat from the walls. These boilers have water or other suitable liquid therein and are provided with a plurality of pipes and nozzles directed at the furnace wall. The heat radiated from the furnace wall causes the water in the boilers to boil and the steam thus produced is directed by means of the pipes and nozzles against the tank walls to exercise a cooling function. Since steam has a higher specific heat than air, a more efficient cooling is obtained, and, more important, the energy utilized in generating the steam is obtained entirely without cost. The energy to heat the water to a boiling temperature is itself removed from the furnace wall so that an even further cooling effect is provided.

There were 6 claims and the following references.

United States Patents

929,899, Thornburg, Aug. 3, 1909; 1,325,172, Sherwood, Dec. 16, 1919.

Foreign Patents

6,680, Great Britain, 1913; and 702,481, Great Britain, Jan. 20, 1954.

Glass Compositions

Vitrifiable Flux and silver compositions containing same. Patent No. 2,822,279. Filed August 6, 1954. Issued February 4, 1958. No sheets of drawings; none reproduced. Assigned to E. I. du Pont de Nemours and Company by William R. Larsen, Fords, and Oliver A. Short.

Silver compositions comprising finely divided particles of silver and a vitrifiable flux disposed in a liquid vehicle have been used in preparing fired-on silver coatings on ceramic objects.

The preferred flux will comprise (A) 60 to 90 per cent Bi_2O_3 and (B) 10 to 40 per cent of an alkali metal-cadmium borosilicate composition containing 5 to 10 per cent alkali metal oxide, 55 to 80 per cent CdO, 10 to 25 per cent B_2O_3 and 5 to 15 per cent SiO_2, with components (A) and (B) together equal to at least 75 per cent, and preferably at least 90 per cent of the total weight of the flux.

Component (A) of the flux can be bismuth trioxide (Bi_2O_3), or any compound such as bismuth subnitrate which yields bismuth trioxide under firing conditions.

Component (B) of the flux may be present in the form of a glass frit prepared by fusing together the desired proportions of an alkali metal oxide, or an alkali metal carbonate, cadmium oxide and boric acid. The melt is fritted by pouring it into water and the resulting frit is dried and ground in a ball mill to a finely divided powder.

The silver composition will usually be prepared by dispersing in a liquid vehicle about 3 to 20, preferably 4 to 10, parts of finely divided particles of silver for each part of flux. The silver particles should be sufficiently finely divided to pass through a screen of 20 mesh size or finer.

Any liquid vehicle which functions to hold the silver and flux particles together and in good admixture can be used in preparing the silver composition.

An acceptable vehicle is composed of 7.3 per cent ethyl cellulose, 23.0 per cent hexaline glycol and 69.7 per cent carbitol acetate, together with small amounts of phosphorated tall oil and diethyl oxalate.

The silver compositions can be fired on ceramic objects over a wide temperature range, e.g. 1200 to 1500° F., to give fired-on coatings which are directly solderable and strongly adherent.

There were 2 claims and the following references cited in this patent.

United States Patents

2,312,788, Andrews et al., Mar. 2, 1934; 2,385,580, Knox, Sept. 25, 1945; and 2,457,158, Kock, Dec. 28, 1948.

Production of Skeletal Glass Catalysts. Patent No. 2,834,738. Filed August 8, 1955. Issued May 13, 1958. No sheets of drawings; none reproduced. Assigned to Imperial Chemical Industries Ltd., by George Clarkson Vincent.

It has been found that by producing skeletal glass catalysts in the form of sintered aggregates there are obtained mechanically strong, highly porous catalysts which may have a higher catalytic activity in many processes, particularly diffusion limited processes, than a skeletal glass catalyst of the same composition used in the form of small pieces of broken glass. This higher catalytic activity is thought to be due to the fact that the sintered glass aggregates may satisfactorily contain skeletal glass particles of a size too small for use as a catalyst in the non-aggregated form.

Twenty parts of alumina, 35 parts of silica, 10 parts of calcium oxide and 40 parts boric oxide were thoroughly mixed in powder form and fused at 1500° C. to give a glass having the following composition:

	Per cent
Alumina	24.7
Silica	35.0
Calcium oxide	8.9
Boric oxide	29.1

The glass is divided into two portions. One portion was broken up into fragments which were mostly about 3 mm. in size but some of which were smaller and the fragments sintered at 850° C. for 24 hours to give suitable aggregates. A soluble phase was then extracted from these aggregates by immersion in hot N/2 hydrochloric acid for 3 hours, and the aggregates washed with water and dried.

The other portion of the glass was broken up into pieces of about 3 mm. size, heated at 850° C. for 24 hours to cause phase separation without sintering and a soluble phase then extracted as described above.

The activities of the sintered and unsintered skeletal glass catalysts were then compared in the debutylation of tertiary-butyl benzene, the tertiary-butyl benzene being passed at a rate of 5 liters per liter of catalyst filled space per hour through a bed of the catalyst maintained at a temperature of 400° C. The sintered glass skeletal catalyst gave a conversion of 48.6 per cent and the unsintered glass skeletal catalyst a conversion of 41.5 per cent, conversion being expressed as moles benzene produced per 100 moles tertiary-butyl benzene processed.

There were 4 claims and the following references cited in this patent.

United States Patents

2,500,092, Parker, Mar. 7, 1950; 2,500,801, Church, Mar. 14, 1950; 2,504,001, Connolly, Apr. 11, 1950; and 2,515,943, Stookey, July 18, 1950.

Glass articles, compositions and methods of producing same. Patent No. 2,825,634. Filed May 18, 1953. Issued March 4, 1958. No sheets of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by Guy E. Rindone.

An article is described that is suitable for use either as a mirror or as an electroconductive article having a base and superimposed thereon a silver film. The base is composed of a glass having a composition that falls within the following ranges of ingredients:

	Per cent by weight
Ag_2O	5 to 60
B_2O_3	30 to 85
SiO_2	0 to 60
Al_2O_3	0 to 20

(*Continued on page* 217)

Study of Surtace Structure of Glass as Related to Its Durability

• ALL GLASS PRODUCTS are subject to attack by chemical action in varying degrees. In this study by H. E. Simpson (February, 1958, the *Journal of the American Ceramic Society*) the author was concerned only with the deterioration of glass surfaces resulting from atmospheric moisture. Attack by moisture is initially evidenced by a slight dimming or a surface scum, followed by the formation of a noticeable film, or in some cases a white stain of varying thickness and pattern, depending on the atmospheric conditions and, what is probably more important, on the composition of the glass. Durability of the surface is especially important when one considers the unfavorable conditions brought about by (a) storage in unheated warehouses, (b) northern climates, (c) the hazards of shipping, and (d) storage in tropical climates where the humidity is extremely high.

Because durability is a surface phenomenon, there is a specific relation to the surface chemistry of glass.

The surfaces of various glass samples were submitted to a controlled high-temperature cyclic humidity test. Alterations in the surface structure were then studied by means of replicas, utilizing various electron microscope techniques. By combining the two techniques, characteristic patterns of deterioration were obtained and it was found that surface failures depended on composition and on previous surface preparation (e.g., grinding and polishing or blowing in a mold).

The author has described cyclic humidity tests which have been useful in the evaluation of ground and polished plate glass, fire-polished window glass, and optical reticules; the glasses ranged from optical crown glass to heavy flint glasses and various container and bottle glasses. The breakdown of these glasses was measured by means of a haze meter. The haze meter measures, by means of a photoelectric cell, the total transmission of the sample and the amount of scattered light. The relative amount of scattering is taken as a measure of haze or surface deterioration. By definition, "haze' is that fraction of the total transmitted light from a normally incident beam which is not transmitted in a straight line.

$$\text{Per cent haze} = \frac{T\text{-}Tr}{T} \times 100 = \frac{Td}{T} \times 100$$

T = total light transmitted.
Tr = amount of light transmitted in a straight line.
Td = amount of light transmitted in all directions except rectilinearly.

In this study of the deterioration of glass surfaces, a replication of the curved surfaces of the container glasses was necessary in order to adapt the haze-meter technique of measurement. Successful plastic replicas were made using solutions of Vinylite in methyl isobutyl ketone. Plotting the per cent haze versus exposure time produced characteristic curves for different types of glasses. This type of information has been shown to be useful in evaluating the surface durability of various glass products.

Frequently there has arisen the question, what erosion products are present when glass surfaces fail and what is the mechanism of breakdown? With the hope of revealing the nature of surface failures, electron microscope studies were made. These studies involved replication of the various eroded surfaces, and it was found possible either to replicate replicas of eroded surfaces or to make replicas directly from the eroded surfaces.

Haze-meter curves for the various types of glasses which were subjected to the cyclic humidity test are shown so that direct correlation may be made with the electron micrographs.

To accelerate the test and produce haze on the surface of the glass as rapidly as possible, it was found desirable to vary the temperature of the test over a definite cycle. As the temperature dropped, a mild or slightly visible fog was produced on the glass; as the temperature rose, this fog cleared completely. The required temperature cycling was produced by means of a cam timer actuated by a slow-speed electric motor which shut off the heat to the oven for 1 hour in each 2 hour cycle. The timer, geared to deliver one revolution every 2 hours, was placed in the electrical circuit. Within the oven a brass-iron thermostat, which governed the temperature during the "on" cycle, acted through a relay, which in turn delivered the current to the heater units.

The method of testing as finally developed provided for the exposure of properly prepared samples to alternate cycles of surface fogging and clearing, consisting of a temperature drop of from 55°C. to about 50°C. and a rapid recovery to 55°C., with the humidity at approximately 100 per cent. The total time for a complete cycle was 2 hours.

Various optical reticules were tested to compare the ability of each to resist surface weathering. All samples were prepared from commerical glass. It should be emphasized that all the glasses were prepared in the same manner and that all samples were ground and polished so as to present a similar type of surface. The method of preparation is very important when comparing surface durability, and it has been found highly desirable to clean all samples in the same way.

The results of the haze-meter tests show a definite relation between the rate of haze formation and the composition of the various optical glasses. The crown glasses were very similar in composition. Each contained a total of 17.1 per cent alkalis. Glass 10E, however, contained 16.1 per cent Na_2O and 1.0 per cent K_2O, whereas glass 3E contained 8.1 per cent Na_2O and 9.0 per cent K_2O. The glass containing the greater amount of Na_2O (10E) seemed to develop haze a little faster than the glass containing the greater amount of K_2O (3E). This slightly accelerated haze development may be due to the fact that potash glasses tend to erode to less opaque films than soda glasses. This difference in durability is rather

(*Continued on page* 211)

TODAY *as in 1929*

there are clear advantages to WEST END SODA ASH

Supplying soda ash to meet the full requirements of western glass container producers has full-time priority at West End. From our first commercial manufacture in 1929 for a pioneer western glass container plant to today's large-scale production incorporating precise quality controls, ample storage and a unique system of fast, dependable service, West End has geared its progressive expansion specifically to the changing needs of this dynamic industry. It is only from the sound, functional base unique with West End that long-range dependability and realistic economy can be assured.

Coarse Dense Glassmakers' containing 1% $Na_2B_4O_7$

also 58% Coarse Granular

WEST END CHEMICAL COMPANY · EXECUTIVE OFFICES: 1956 WEBSTER, OAKLAND 12, CALIF. · PLANT: WESTEND, CALIF.

DIVISION OF Stauffer STAUFFER CHEMICAL COMPANY

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during January, 1959, was as follows: *Flat Glass*: a preliminary figure of 19,900 for January, 1959, indicates an increase of 1.0 per cent over the adjusted figure of 19,700 reported for December, 1958. *Glass and Glassware, Pressed and Blown*: a decrease of 2.2 per cent is shown by the preliminary figure of 79,500 reported for January, 1959, when compared with the adjusted figure of 81,300 reported for December, 1958. *Glass Products Made of Purchased Glass*: the preliminary figure of 14,300 given for January, 1958, is equal to the previous month's adjusted figure, also 14,300.

Payrolls in the glass industry during January, 1959, were as follows: *Flat Glass*: an increase of 3.4 per cent is shown in the preliminary $11,772,531.35 given for January, 1959, when compared with December's adjusted $11,382,769.34. *Glass and Glassware, Pressed and Blown*: a decrease of 2.4 per cent is shown in the preliminary $29,962,305.03 reported for January, 1959, when compared with the previous month's adjusted $30,704,105.96. *Glass Products Made of Purchased Glass*: a preliminary figure of $4,505,249.75 was reported for January, 1959. This is a decrease of 6.8 per cent when compared with the adjusted figure of $4,810,721.92 for December, 1958.

Glass container production: production based on figures released by the Bureau of the Census, Industry Division, was 11,416,000 gross during February, 1959. This is a decrease of 0.7 per cent under the previous month's production figure (revised) 11,504,000 gross. During February, 1958, glass container production was 10,833,000 gross, or 5.1 per cent under the February, 1959, figure. At the end of the first two months of 1959, glass container manufacturers have produced a preliminary total of 22,920,000 gross. This is 1.8 per cent more than the 22,494,000 gross produced during the same period in 1958.

Shipments of glass containers during February, 1959, came to 10,510,000 gross, a decrease of 6.2 per cent under January, 1959, which totaled (revised) 11,209,000 gross. Shipments during February, 1958, amounted to 10,703,000 gross, or 1.8 per cent more than February, 1959. At the end of the first two months of 1959, shipments have reached a preliminary total of 21,719,000 gross, which is 0.9 per cent more than the 21,500,000 gross shipped during the same period the previous year.

Stocks on hand at the end of February, 1959, came to 18,938,000 gross. This is 0.9 per cent more than the 18,771,000 gross on hand at the end of January, 1959, and 4.6 per cent more than the 18,101,000 gross on hand at the end of February, 1958.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers

	February, 1959
Food	1,065,000
Medicinal and Health Supplies	1,291,000
Chemical, Household and Industrial	886,000
Toiletries and Cosmetics	785,000
Beverage, Returnable	479,000
Beverage, Non-returnable	70,000
Beer, Returnable	111,000
Beer, Non-returnable	532,000
Liquor	744,000
Wine	353,000
Sub-total (Narrow)	6,316,000

Wide Mouth Containers

Food	* 3,073,000
Medicinal and Health Supplies	348,000
Chemical, Household and Industrial	139,000
Toiletries and Cosmetics	300,000
Packers' Tumblers	28,000
Dairy Products	143,000
Sub-total (Wide)	* 4,031,000
Total Domestic	10,347,000
Export Shipments	163,000
TOTAL SHIPMENTS	*10,510,000

*This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production Feb., 1959	Stocks Feb., 1959
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics	Narrow Neck	4,278,000	6,380,000
	Wide Mouth	* 4,186,000	6,027,000
Beverage, Returnable		762,000	2,079,000
Beverage, Non-returnable		92,000	247,000
Beer, Returnable		190,000	567,000
Beer, Non-returnable		574,000	1,028,000
Liquor		768,000	1,360,000
Wine		365,000	833,000
Packers' Tumblers		28,000	96,000
Dairy Products		173,000	321,000
TOTAL		*11,416,000	*18,938,000

*This figure includes Fruit Jars and Jelly Glasses.

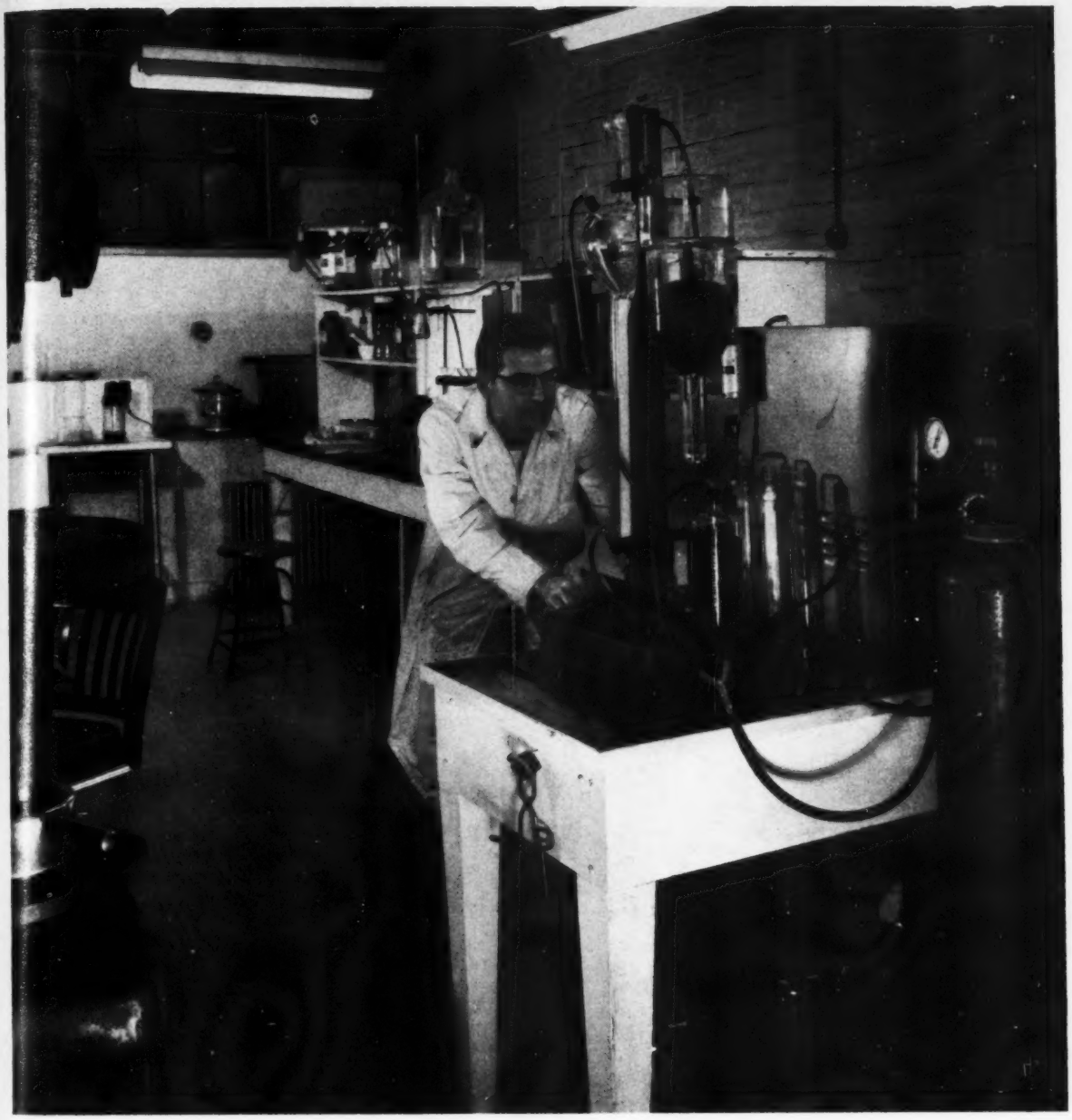
BROBERG PROMOTED BY T. L. SMITH

Leonard E. Broberg has been appointed vice president in charge of engineering of the T. L. Smith Company. He joined the company in 1956.

PRESSED AND SINTERED GLASS

Corning Glass Works has developed a pressed and sintered glass which can be sealed directly to stainless steel. The multiform glasses are made from minute glass particles which are pressed to shape and then fired at high temperatures. These particles are consolidated by fusion into a non-porous vacuum-tight structure.

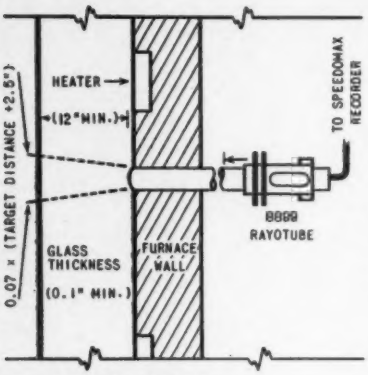
The parts are said to retain the thermal endurance, corrosion resistance and dielectric strength of the parent glass.



production prerequisite

No. 1 Quality Control Center at Overmyer is the foundry laboratory that tests and controls the constant level of chemical properties in each batch of iron. These tests, constantly applied, assure absolute adherance to customers' specifications and varying requirements. It's another step in cautious compounding of a customer's prescription . . . another measure to maintain the high standards of Overmyer mould irons. Overmyer Mould Company, Inc., Winchester, Indiana; Greensburg, Pennsylvania and South Gate, California.

New Equipment and Supplies



GLASS SURFACE TEMPERATURES

Leeds & Northrup Company, Philadelphia, Pa., is offering a newly-designed Rayotube Detector especially constructed to measure glass surface temperatures. Producers of flat and plate glass, according to the company, can have reliable, reproducible indication of glass skin temperature Measurements are unaffected by any glass thickness of over one-tenth inch.

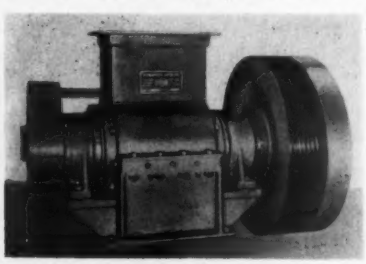
The instrument is sighted directly on the surface of the glass itself and has an internal infrared filter that screens out undesirable radiation so that only surface radiation is measured. The device can measure the temperature of either stationary or moving glass.

ZIRCON BRICK

The Refractories division, H. K. Porter Company, has developed a zircon brick for glass melting furnaces. The outstanding characteristics of the "PZ" Zircon, according to the company, are P.C.E. above cone 42, high density, low permeability, good strength, good volume stability, excellent workmanship, and high resistance to thermal spalling.

PREPARING CULLET

Robinson Manufacturing Company, Clifton, N.J., has developed a new line of sawtooth crushers, called Laptooth, which can be used for preparing cullet with maximum capacity per horsepower.



Spaced ranks of hardened alloy steel crusher "saws" of 9¼", 12¼" or 16" diameter rotate toward one another on horizontal hexagonal shafts turning at differential speeds. All wearing parts are interchangeable.

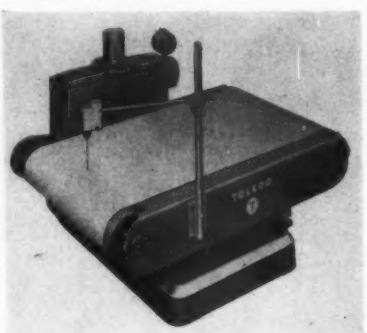
For optimum throughputs, material should be fed at tooth acceptance rates. Long work pieces are generally fed endwise. Cakes, slabs and large broken sections should be fed edgewise and vertically.

SCREENING FEEDER

Syntron Company, Homer City, Pa., has developed a small, high-speed screening feeder for the efficient, rate-controlled simultaneous screening and feeding of powders and other fine bulk materials in relatively small quantities. The feeder is electromagnetically vibrated.

CHECKWEIGHER

Toledo Scale, division of Toledo Scale Corporation, Toledo, Ohio, has announced an automatic high-capacity checkweigher, designed to check the weights of items from 50 lbs. to 200 lbs. It will handle packages—depending on size—at speeds of up to 40 items per minute with an accuracy of approximately one part in 3000.



The unit can be furnished with remote zone indication stations that provide a continuous visual check of the operation.

PROTECTIVE HEAT CLOTH

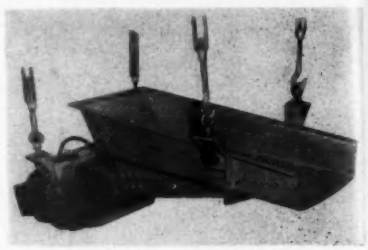
Frommelt Industries, Dubuque, Iowa, is offering a protective heat cloth made of aluminum sheet foil laminated on glass cloth fabric. Marketed as "Ray-Foil," this fabric gives positive protection to personnel by reflecting radiant heat. It is flexible and easy to use as a curtain, shield and panel, and is available in 36" width with panels buttoned together to make any length or height required.

LIFT TRUCK

Towmotor Corporation, Cleveland, Ohio, has a lift truck equipped with a special five-prong fork attachment that enters spaces in the bottom layer of the unit load. More warehouse space per square foot, says Towmotor, is available as a result of the high-stacking ability of this lift truck which has a 168" lift.

VIBRATORY FEEDER

Eriez Manufacturing Company, Erie, Pa., has developed a new Hi-Vi vibratory Feeder with a capacity rated at 50 tons per hour. The unit has the Eriez electro-permanent magnetic drive system which operates directly from alternating current without a rectifier;

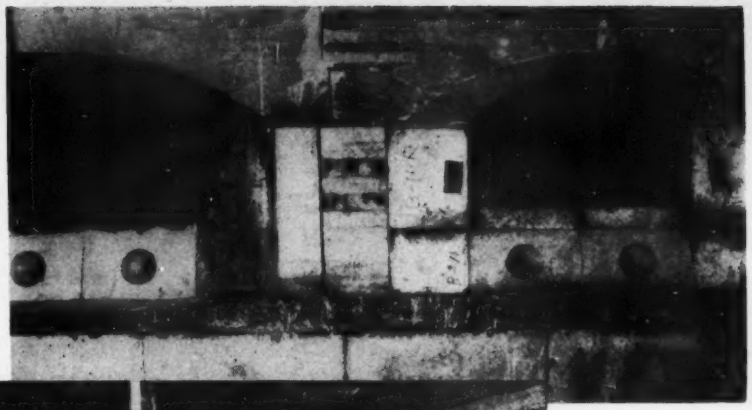


it is completely enclosed and requires no attention.

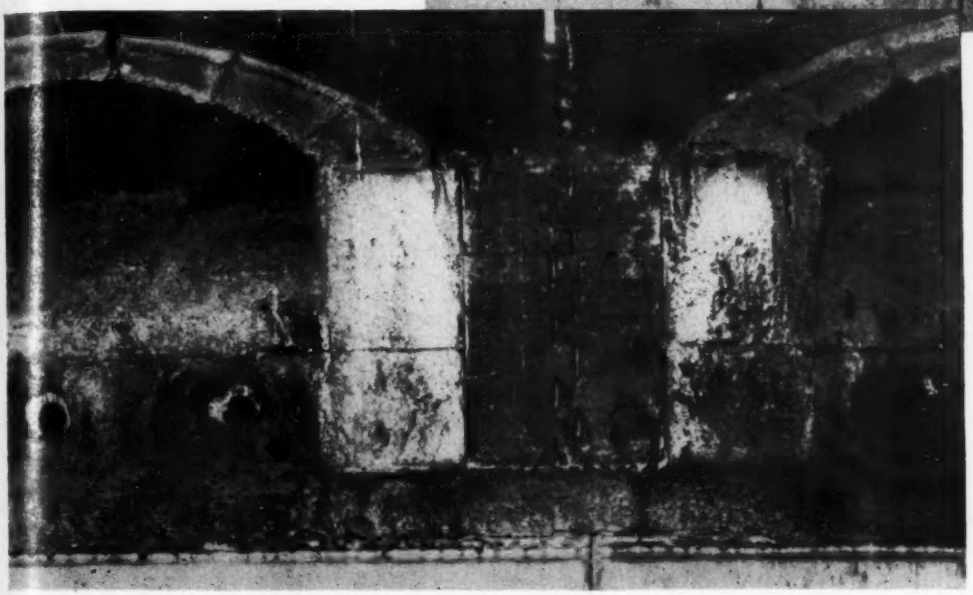
While essentially an automatic constant-volume feeder of bulk materials in a wide range of particle sizes, this unit is also ideally adapted to spreading, drying or agitating materials, handling hot materials, or moving materials into hot areas, states the company, at a precise rate.

ADHESIVE FOR GLASS

Williamson Adhesives, Inc. has announced a "plastic Mastic" general repair kit which is permanently effective with glass, ceramics, metals and many other materials, according to the company. Made of a new epoxypolyamide chemical compound, the material is supplied in quart, half-gallon and two-gallon sizes. Each kit consists of two cans of equal size, containing the white base and black hardener, respectively. Equal parts are mixed and, in its cured form, the Plastic Mastic can be sanded, drilled and machined to a smooth surface.



Ports 3 and 4, right side, oil-fired tank, four-port, side-fired furnace, with "Shamva" invert arches. And same ports at the end of 2½-year campaign. Tank will begin new campaign with these arches intact. *Photos and Data courtesy of Henry F. Teichmann, Inc.*



Before and After Photos of

"Shamva" Mullite Brick

after 2½ years' service . . . now beginning another campaign!

Proved again! . . . Proved that low porosity, "Shamva" Mullite is the economy champion in glass tank refractories.

This demonstrated ability to withstand constant chemical attack from alkaline dusts and volatile fluxes for *years* means . . . more tonnage per campaign and longer, more economical campaigns in any glass furnace operation.

"Shamva" Mullite refractories are available in a full line variety of brick, special shapes and specialties for every glass tank requirement.

For information on shipments, prices, or *any* refractories problem, write *Mullite Works, Refractories Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh 19, Pa.*

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DIVISIONS: Connors Steel, Delta-Star Electric, Disston, Forge & Fittings, Leschen Wire Rope, Mouldings, National Electric, Refractories, Riverside-Alloy Metal, Thermoid, Vulcan-Kidd Steel, H. K. Porter Company (Canada) Ltd.

NEW BOOKS

The Structure of Glass—Proceedings of a Conference held at Leningrad in Nov. 1953. Translated by the Consultants Bureau; 291 pages (1958) $20.

This volume summarizes the extent of knowledge about the structure of glass in the Soviet Union as of 1953. The material which is covered is so broad that the treatment of any one subject lacks depth, a minor and not-so-surprising defect. What is especially striking is the lively discussions which show the diversity of opinions on every experimental report.

This proves that the structure of glass is still an enigma. In a day when research in solid state physics usually begins with an exact knowledge of the structure—sometimes the position of atoms are reported with an accuracy of 1/100 Angstrom unit—the researcher in glass is handicapped with disagreement on the nature of the glassy state. Consequently, the direction of the arguments found in this volume are different from those usually encountered in physics. Whereas, the physicist often predicts the physical properties based upon knowledge of the structure, and then compares the results with experiments—in this field the results of experiments are used to bolster preconceived notions of the structure of glass.

This situation, unhappily, often leads to unresolved and fruitless debates because there is no way of knowing if a preconceived hypothesis is the *only* hypothesis which will lead to measured results. *The Debate on the Structure of Glass* is a title which would describe this volume. Circumstantial evidence is marshalled to support one view over another; the power of logic is often blunted in the confusion over ambiguous words—what is "random," what is "crystallite," what is "long-range order;" and there are some examples of circular reasoning.

Individual experiments are described, but the focus of attention is on their implications concerning structure. Is glass a random-network (after Zachariasen), or microcrystalline (after Lebedev and others) or is it something of both? Sometimes the argument is posed in alternate language—is glass microscopically homogeneous? The reader will be disappointed to find no conclusive evidence for any of these views, although neither of these views fits all the facts.

The conferees generally grouped into two sets with opposing opinions. The microcrystalline hypothesis held the loyalties of Academician A. A. Lebedev, K. S. Evstropyev, E. A. Porai-Koshits, V. A. Florinskaya, A. I. Sevchenko and others. A. A. Appen and E. F. Gross however, found no evidence for regions of chemical heterogeneity (except in borosilicates), and must be regarded as proponents of ideas on structure similar to those of Zachariasen. There was also a middle ground—O. K. Botvinkin and P. V. Geld emphasized that crystallites were qualitatively different from crystals and suggested that glass may be regarded as consisting of separate centers, small cells surrounded by greatly deformed lattices which pass into random networks.

A good illustration of the way experiments are variously interpreted is provided by the report of V. A. Florinskaya and R. S. Pechenkina. They measured the infrared transmission of several modifications of silica including vitreous silica. They found that the fundamental frequencies of crystalline and vitreous silica nearly coincided, and used this as evidence for crystalline regions in glass. However, E. F. Gross said that a random network would have bands in the same way, and held that the experimental evidence was inconclusive.

The conclusions of the conference were not all negative. It was held by a number of authors (V. S. Molchanov and G. M. Bartenev) that the distinction between the small regions of ordered structure of the one theory and the region of short-range order of the other theory is slight. G. I. Skavani suggested that some properties which stress the absence of long-range order (viscosity) can more suitably be described by the network hypothesis, whereas other properties which deal with short-range properties (light absorption) might be better described with the other hypothesis.

The book contains a great deal of factual information, which is not stressed in this review since it was not stressed in the discussions. New results on x-ray diffraction, Raman spectra, infrared spectra, expansivity, chemical resistance, Rayleigh scattering, luminescence, viscosity, dielectric loss, conductivity, oxygen potential, electron diffraction, and electron microscopy were reported.

This book is required for the serious student and researcher of glass science. It summarizes the state of knowledge on this subject more effectively than any other

NOTE: This is a more complete review of the same book which was mentioned in this column last month.

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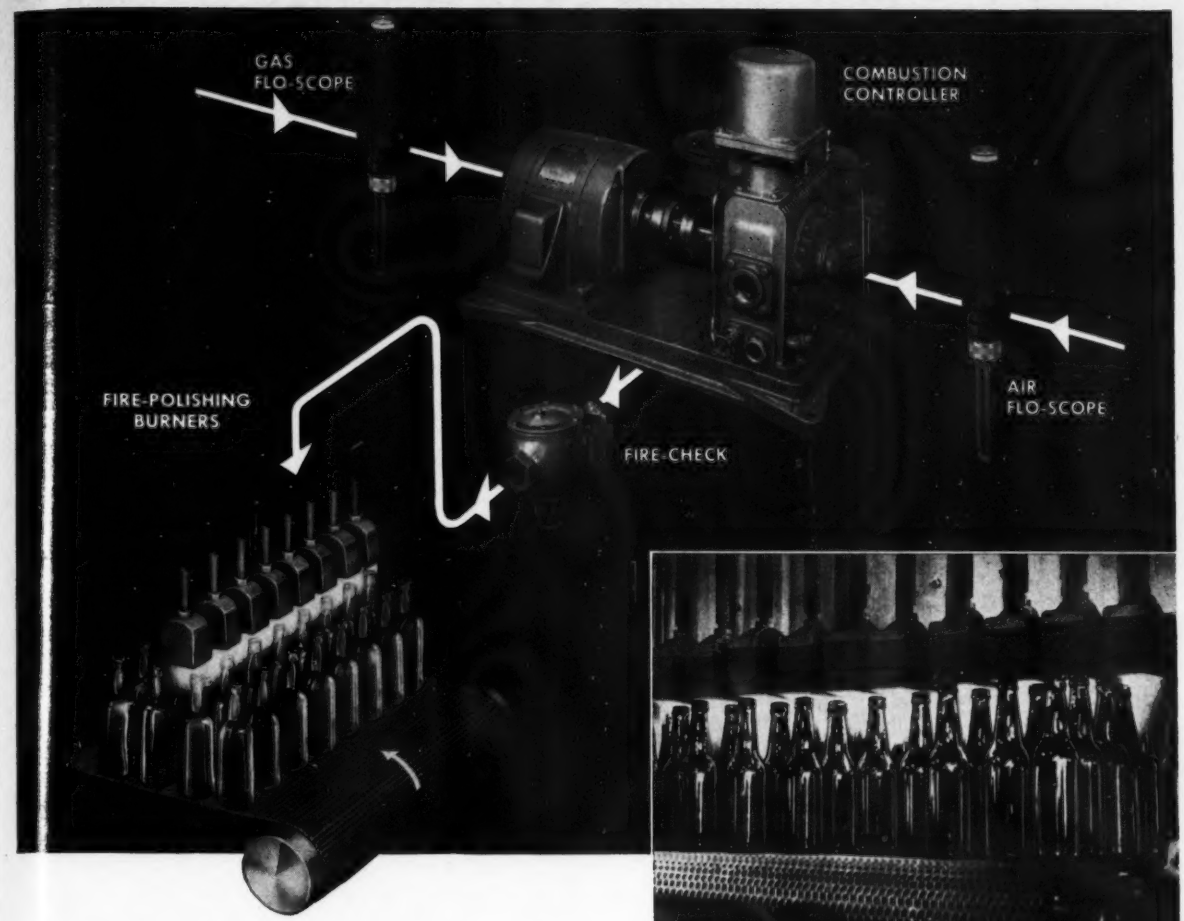

Fire-glazing beverage bottles by directing flame from specially-designed Selas burners down over mouths of bottles as they enter annealing lehr.

Selas Burners speed-up bottle mouth fire-glazing . . . increase surface luster

This manufacturer uses Selas burners to remove cutting edges and mold marks, to seal incipient cracks and fissures and to increase surface luster of bottle mouths.

These burners, dimensioned exactly to size of workpiece, envelope bottle-mouths with low velocity combustion products. Burners are specially-designed for high capacity and flame retentive quality and are independently controlled.

To assure the most efficient operation of Selas fire-polishing burners, the bottle manufacturer utilizes this complete Selas combustion package:

- Combustion Controller—makes possible fast heating and close control, by delivering gas-air mixture to burners at preset ratio and pressure. Completely automatic; no labor required in its operation. Factory Mutual approved.
- Flo-Scopes®—installed at the inlets to the Combustion Controller, Flo-Scopes measure rates of flow of gas and air and permit accurate determination of gas-air mixture ratios.
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Selas offers a complete line of standard burners including Duradiant®, Refrak, Spear-Flame, Superheat and Ribbon.

Combustion Controllers . . Flo-Scopes . . Fire-Checks . . Burners . . are available as individual items or as a complete combustion package.

For descriptive literature on any of the above combustion components, write Dept. 124, Selas Corporation of America, Dresher, Pa.

Duradiant and Flo-Scope are registered trade names of Selas Corporation of America.

SELAS CORPORATION OF AMERICA DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

book in the western world. Its controversial tone indicates the true unsettled nature of the subject, whereas many texts emphasize the non-controversial aspects. It will be an eye-opener for those who believe that the views on glass are dogmatic behind the iron curtain.

The book has a large number of illustrations. The binding is of high quality, and the typography legible. The Consultants Bureau has kept the translation errors to a minimum.

A. C. S. Annual Meeting

(*Continued from page* 181)

lows. Other important honors to be awarded are the Ross Coffin Purdy Award, the John Jeppson Medal, and the Charles Fergus Binns Medal.

David Swan, vice president of research, Linde Company, division of Union Carbide Corp., will deliver the Orton Memorial Lecture. Mr. Swan has written many papers on the subjects of metallurgy and welding.

There will be two contests in which students of ceramic schools will participate for prizes. The tenth annual Ferro Student Contest prizes will be awarded during the Enamel Division program. Ben F. Sweo, technical director of Ferro Corporation, will make the presentations.

On Sunday afternoon the semi-finals of the annual student speaking contest will take place, and the four finalists will compete Sunday evening. William J. Knapp, University of California, and vice president of the Ceramic Educational Council, will be in charge.

Ladies' Entertainment

A special entertainment program for the ladies will enable them to visit the Merchandise Mart, see a demonstration of cosmetics and hair styling with a hat show, and take part in luncheons and parties. On Wednesday afternoon the ladies may join the Design Division for its afternoon program when a panel of delegates to the Congress for Better Living will discuss home furnishings of the present and future.

Plant Trips

The 5-day Annual Meeting will conclude on Thursday with trips to ceramic plants in the Chicago area where the ceramists will have the opportunity to view factory operations, laboratories and products.

A Straight-Line Inspection Method for Glass Containers

(*Continued from page* 184)

at the ware as it passes before her, without any physical effort other than to remove the rejects. Although this procedure has eliminated practically all physical fatigue from inspecting, we find it advisable to rotate inspectors from station to station to relieve the monotony and assure uniform accuracy.

When the containers have cleared the visual inspection stations they are again regrouped to permit bottom inspection and carton-packing. In some plants we use a reciprocating arm which automatically pushes containers from a single narrow line so that they are positioned

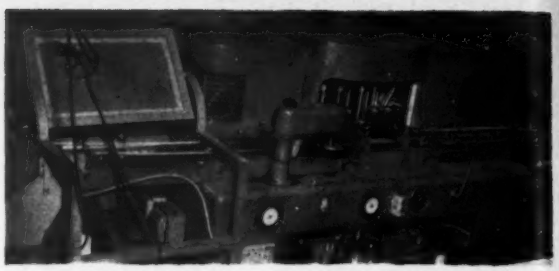


Fig. 9. When required, a cleaner can be included in the inspection line.

across a wider belt. In other plants we use a rotary accumulating table to bring the containers together. The end-purpose is the same regardless of the equipment used —to make it easier for the operators at this station to grasp several glass containers at a time, turn them over for bottom inspection and then pack them into cartons.

Improved Quality Through Cullet Analysis

Like some of the other innovations we have made on our inspection setup, we have found that our new cullet-collecting system has by-product advantages. This system starts with a conveyor at the pack-off station and continues along the entire inspection layout so that the packers, visual inspectors and automatic stations can divert defective ware to this common conveyor which discharges it in a cullet disposal area. This arrangement not only provides an economical means of handling cullet,

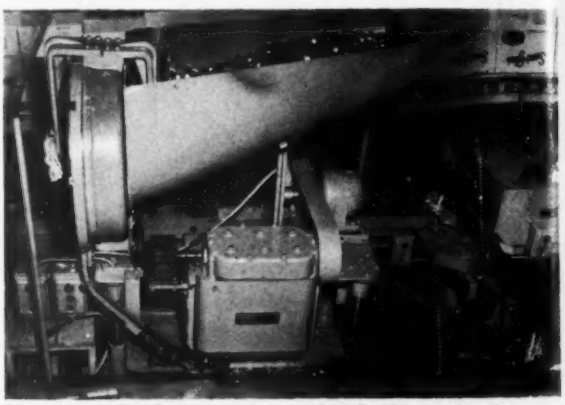


Fig. 10. A bottle-capper is a helpful adjunct in the prescription ware inspection line.

but it also is effective in preventing tramp glass from getting into the system.

As we have seen, progressive inspection has reduced the possibility of defective ware being cartoned. But, in conjunction with the cullet-collecting system, it is helping us to improve the quality of glassware before it actually reaches the inspection line. Since each station —automatic or visual—centers on a specific kind of defect, we have been able to isolate the various types of defects by simply placing a receptacle at any particular reject chute and anlyzing the resulting cullet. Based on information brought to light through such studies we have made certain equipment design changes which have had an important bearing on quality improvement. In addition, we find the new setup helpful in production quality control.

(*Continued on next page*)

Through the use of counters and warning devices we know when rejections at any station rise above a pre-established rate. Such information can be fed back quickly to the forming department, where adjustments are then made to bring the product back to standard.

Flexibility in the arrangement of components is an important feature in any system. Should quality control require it, we can include an anutomatic cleaner in the system for removing glass that might result from lehr breakage, or for removing dirt or other loose foreign substances. This is a particularly useful procedure when handling wide-mouthed containers.

We have also been able to install an automatic capper in our prescription ware line, as an integral part of the continuous-flow setup. This is located just before the regrouping and pack-off equipment.

Engineers of Island Equipment Corp. have worked closely with us in developing six individualized systems for our Freehold, New Jersey, plant and four at our Brockway, Pennsylvania, plant.

Although we are gratified at the results we have secured to date, we are not complacent about the future. We feel that the techniques of automatic inspection are still in their infancy, and that many new and wonderful advances lie ahead in this field.

We are convinced however, that much of the spadework is behind us and that the inspection techniques we have developed will keep pace with any foreseeable output delivered by our lehrs, enabling us to include automatic inspection innovations as they are introduced.

Heat-Resistant Zinc Borosilicate Glasses

(*Continued from page* 185)

durability, and surface devitrification.

The sag point is the temperature above which a fiber of glass sags under its own weight, and indicates the temperature at which the glass will deform. The sag points of the zinc borosilicate glasses ranged from 585°C to 665°C, which is the approximate temperature range of the sag points of most commercial borosilicate and silicate glasses.

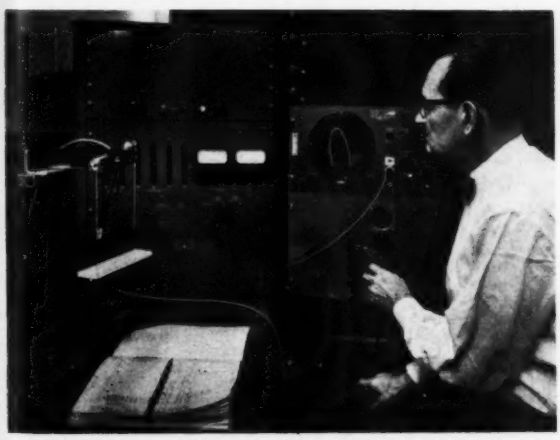


Fig. 3. The resonant frequency of a glass specimen (lower left) is being determined at the National Bureau of Standards for use in calculating Young's modulus. The frequency is indicated by counter on the left. The oscilloscope (right center) indicates when the resonant frequency of the specimen has been reached. The zinc borosilicate glasses studied had high values of elastic moduli.

Fig. 4. The linear thermal expansion of a glass specimen in the furnace (right) is being determined at the National Bureau of Standards by an interferometric method.

All of the clear glasses had liquidus temperatures between 950° and 1000°C. Glasses containing less than 55 mole per cent ZnO were characterized by the presence of thin films on the top surface of the cast specimen. These films varied in thickness and produced interference colors in reflected light. The refractive indices of the glasses ranged from 1.6409 to 1.6798 (Fig. 2).

Modulus of elasticity was obtained for four of the glasses by determining the resonant frequency (Fig. 3) of specimens approximately 5⅝" x 1½" x ⅓". The glasses had Young's modulus values of 836 to 860 kilobars[2] (12.1 x 10^6 to 12.5 x 10^6 lb/sq in.) and Poisson's ratios of about 0.3, both of which are higher than those reported for common optical glasses.

Between 25°C and 100°C, the linear coefficients of thermal expansion (Fig. 4) for the glasses ranged from 3.2 x 10^{-6} to 3.8 x 10^{-6} per degree C. They were thus comparable to the thermal expansions of some commercial heat resistant glasses. Between 100°C and 400°C, the average coefficients were higher, 5.0 x 10^{-6} to 5.3 x 10^{-6}. These values, however, are considerably lower than those for most sheet and plate glasses, which are between 7.0 x 10^{-6} and 10.0 x 10^{-6}.

The chemical durabilities of three glasses were determined in solutions buffered at different pH values. The addition of SiO_2 to the zinc borate glasses did not improve their resistance to acids but did improve their resistance to strong alkali. The chemical tests indicated that the glasses should be serviceable in contact with water or neutral solutions.

During annealing, the two-component ZnO-B_2O_3 glasses developed a dull appearance on their exposed surfaces. The amount of this surface devitrification varied with the time and temperature of heat treatment. The three-component glasses, containing as little as 5 mole per cent SiO_2, maintained a brilliant transparent surface during annealing.

Glasses with the low thermal expansions shown by the zinc borosilicate glasses should be more resistant to thermal shock than commercial plate and sheet glasses. The

glasses show possibility of being further developed to provide greater thermal-shock resistance by adding other components such as Al_2O_3, CaO, MgO, SrO, ZrO_2, and TiO_2.

REFERENCES

1. For further technical details, see Properties of zinc borosilicate glasses, by E. H. Hamilton, R. M. Waxler, and J. M. Nivert, Jr., J. Research NBS 62, 59 (Feb. 1959) RP2930.

2. One kilobar is equivalent to 1 x 10^9 dynes/cm².

The Care of Platinum Thermocouples

(*Continued from page* 191)

tensile strength of platinum and rhodium-platinum alloys used for thermocouple purposes. The breaking load of a pure platinum wire 0.020 inch diameter (the normal thermocouple size) is therefore about 7 lb. at room temperature; at 1400°C the breaking load is only 12 oz. This represents a load instantly applied; under prolonged loading, particularly at high temperatures, the wire will withstand only a fraction of this load. This type of failure is known as "creep", and it has been shown as the result of creep tests that the safe loading for platinum is about 4.9 tons per square inch.

Creep Tests on Thermocouple Alloys

In order to compare the resistance to creep at high temperature of the platinum alloys normally used for thermocouples, annealed wires, 0.020 inch in diameter, were suspended under various loads in a furnace at a constant temperature of 1400°C. The investigation was limited to short-time creep tests and no attempt was made to determine the limiting creep stress at any temperature, but the results are sufficient to indicate the comparative creep resistance of these alloys.

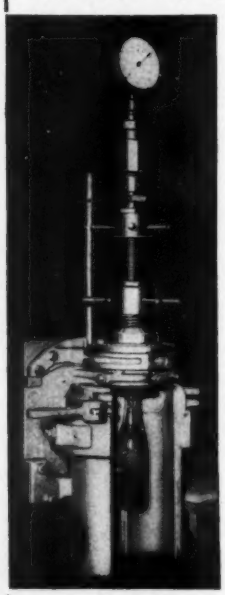
Hardness and Tensile Strength of Platinum Alloys at Room Temperature

Rhodium per cent	Hardness VPN	Tensile strength tons per sq. in.
0	40	10
5	66	16
10	85	21
13	91	23
20	106	27
30	124	30

Fig. 1 is a graph plotted on a log-log scale showing the results of these stress-to-rupture tests at 1400°C. The practical results are perhaps better illustrated in Fig. 2, which shows the load required to fracture the wire in 250 minutes. It will be observed that 10 per cent rhodium-platinum alloy will withstand about eight times the loading of pure platinum at 1400°C, but above 20 per cent of rhodium there is little gain in creep resistance.

Heating under load at 1400°C produced very large grain growth in the pure platinum, the wire practically consisting of a chain of large crystals of the diameter of the wire. Under prolonged stress at low loads grain boundary sliding occurs at shown in Fig. 3, and ultimately leads to a brittle type of fracture, which is occasionally found in a couple after long service at a high temperature. Grain growth is far less evident in

MAXIMUM INDICATION GAUGE with Manual Reset Free Pointer



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O. N. Break Type BOTTLE TESTER

- **BREAKING PRESSURE** is temporarily recorded by a manual reset free pointer.
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- **TESTING IS SAFE** as the bottle breaks inside of a safety shield and the parts drop harmlessly into a container.
- **TESTING IS FAST** as there are no weights to handle and the required operations are simple and convenient.

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the 5 per cent rhodium-platinum alloy creep sample illustrated in Fig. 4, but cracks have developed at many of the grain boundaries.

The 5 per cent rhodium-platinum: 20 per cent rhodium-platinum thermocouple, which can be used continuously at temperatures up to 1700°C, has greatly improved creep resistance by comparison with the platinum: 13 per cent rhodium-platinum couple, the 5 per cent alloy wire having about five times the strength of platinum at 1400°C. In conditions of extreme loading the 20 per cent rhodium-platinum: 40 per cent rhodium-platinum couple has an even greater advantage, but against this must be set the much smaller e.m.f. of the 20/40 couple and also its increased cost.

Examination of Service Failures

In practice, however, it is seldom necessary to impose upon the thermocouple anything like these loads. A thermocouple placed horizontally rests on the sheath, but, if a thermocouple has to be placed vertically, care must be taken to ensure that the weight of the insulators does not apply a tensile stress to the wire. This can be overcome by allowing the hot junction to rest on the sealed end of the sheath. It is undesirable to remove a thermocouple from a hot sheath, particularly if there is any undue friction, as this will impose a considerable stress on the wire. Thermocouples that have failed in service are generally found, by spectrographic examination, to have been contaminated, resulting in embrittlement of the wire. Occasionally, even where there is no obvious contamination, there are clear signs of stress failure. Fig. 5 is a photomicrograph of 13 per cent rhodium-platinum, said to have failed after two months service at about 1100°C.

Spectrographic examination showed no contamination but there is considerable grain growth and sliding at the grain boundaries leading to rupture, which is typical of slow tensile deformation at high temperature and indicates that the wire has been subject to appreciable stress in service.

The practical significance of the points that have been made is clearly the great importance of handling thermocouple wires as little as possible in assembly and of ensuring that they are completely free from any kind of foreign matter when put into service.

Research Digest

(*Continued from page* 200)

slight, and the important fact is that these glasses, which are quite similar to the plate and window glasses studied previously, develop haze much faster than the other types of optical glasses. All the flat glasses developed considerable haze within the first 15 days of exposure and at the end of 60 days were well decomposed at the surface.

The dense barium crown glass showed a greater resistance and at the end of 60 days developed less than half the amount of haze developed by the crown glasses. Beyond 60 days of exposure, the development of haze was extremely slow.

The borosilicate crown showed still greater resistance to attack by moisture. This glass developed less than 10

How well do you know your glass?

THIS IS A:

- ☐ 1. Fiber-glass-covered sofa pillow
- ☐ 2. Paperweight
- ☐ 3. Witch ball
- ☐ 4. Glass simulation of a famous gem

If you checked No. 3, you're right. "Witch balls," like this one made in Sandwich, Massachusetts, in 1850, were said to be used in the homes of superstitious Irish immigrants. Witches, weary of pulling the "endless" strand of yarn with which the ball was filled, would supposedly leave the house. But there are no "strings" attached when you choose Wyandotte Soda Ash . . . for nearly 70 years Wyandotte has been serving the glass industry. Today, as in the past, Wyandotte is a working partner supplying technical assistance and raw-material chemicals to those great companies marking milestones in glass progress.

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per cent haze after 60 days of exposure, and the subsequent haze was very slight with continued exposure up to 175 days.

The remaining glasses tested were flint glasses, all of which showed remarkable resistance to attack by moisture. Glass 11E, a crown flint glass, exhibited the greatest amount of attack of all the flint glasses. Incidentally, this glass contained the least amount of PbO of all the flint glasses studied. The greatest amount of deterioration occurred within the first 20 days of exposure, and beyond this point and up to 200 days there was little increase in the haze developed. All the remaining lead-bearing glasses showed very little haze when exposed as long as 456 days.

Previous tests indicated that the surface durability of container glasses could best be studied by the use of replicas in order to apply successfully the haze-meter technique to the curved surfaces. The procedure also had the added advantage of showing the surface durability of both the inside and outside of the container.

The rate of haze formation on the inside of glass No. 1, a high-lime glass, was rather rapid and 45 per cent haze developed after 30 days of exposure. The per cent haze on the outside followed that of the inside but did not quite equal the inside after 30 days of exposure.

The rate of haze formation on glass No. 13, a high-alumina glass, was much less than that of the high-lime glass. Only 3 per cent haze developed after 30 days of exposure. The inside and outside surfaces showed about an equal amount of haze.

The results of these tests have been confirmed by industrial warehouse storage tests and it is thus indicated that the haze tests have considerable practical value. Details of these practical tests have been given.

Two electron microscope techniques were employed to study the degree of attack and appearance of the eroded surface of some of the glass samples. The first was the Collodion and Carbon Technique and the second was The Lacquer Technique.

The identity of the various decomposition products as revealed by the electron micrographs is not specifically known.

The haze-meter curves indicate that the glasses of poor durability show a marked increase in haze after 5 to 10 days of exposure in the cyclic humidity cabinet; the breakdown is definitely associated with the pronounced break or vertical slope of the haze-meter curves. It is important to know, however, that some glasses do not show the vertical break at all, at least in the time these tests were conducted (300 days for some of the optical flint glasses). In most instances these glasses are the better ones, as demonstrated in the durability tests.

Perhaps the breakdown of a glass surface is associated with the adsorbed moisture film on the surface of the glass; in due time the moisture penetrates the surface in a rather selective manner and an alkaline silicate of some type is ultimately formed. This type of leaching has been demonstrated by Hafner and Jones, by Dick et al., and by Raggon and Bacon. The silicate products are believed to hydrolyze later to form sodium and potassium hydroxide, followed by reactions with the CO_2 of the air to form alkaline carbonates. These carbonates are readily soluble in water and may be removed rather easily by washing. This phenomenon has been observed many times by the author when building up rather severe and corrosive films by means of the cyclic humidity procedure. The materials remaining on the surface of the corroded glass are either traceries of silica or highly siliceous deposits or some more resistant or less soluble carbonates, e.g. calcium carbonate. X-ray diffraction charts made from samples of corroded surfaces have indicated that the principal line is that of calcium carbonate. Sample 10E-5 had a weak line at 29.4° that corresponds to a "d" spacing of 3.04 a.u., which is the spacing for calcium carbonate.

The high-alumina container glass showed remarkable resistance to attack by moisture after 30 days of exposure. In the electron micrograph the surface appears to be smooth, and moisture apparently had not gained a foothold for selective action. This reaction is quite in contrast to that shown by sample 1-1A in which definite etching is evidenced after only 3 days of exposure. Iler has pointed out that Al_2O_3 tends to shield or to repel the OH groups from the surface of glass, and therefore one would expect less attack. It appears that by means of controlled deterioration, brought about by the use of the cyclic humidity technique, glass surfaces may be weathered to any desired stage and that by means of the replica technique for electron microscopy an enlarged view of the destruction of the surface may be studied.

It is therefore hoped that by combining these techniques, a better knowledge of not only the durability but the chemistry of the surface of glasses may be revealed.

The Evaluation of Several Infrared Transmissive Glasses

(*Continued from page* 189)

fortunately the thickness difference masks the effect.

Figure 7 shows composition 52 containing no silica and 51 wherein half of the soda is replaced by silica. Substantial increase of transmission results. Figure 8 shows composition 61 containing silica and no soda compared to 62 with soda completely substituted for the silica. While the curves are practically identical, note the larger thickness of 61 containing silica. Since it is just as transmissive at the greater thickness it is valid to conclude that replacement of soda by silica improves the transmission.

Figure 9 shows that a small change in the calcia-alumina ratio has either no effect or one so minor that it is indistinguishable from that due to thickness difference. Figure 10 shows partial substitution of soda by potassia. Since the difference in transmission is much larger than can be atttributed to thickness alone it is concluded that increased soda at the expense of potassia improves the transmission in this glass. Figure 11 shows the effect of substituting silica for lithia in a glass (82) originally containing no silica. Even though 91 is thicker it is more transmissive and therefore this substitution improves transmission.

Figure 12 shows the effect of substituting silica where there previously was none (82) for part of the alumina. Again the silica bearing glass (83) even though much thicker is more transmissive. Figure 13 demonstrates the effect of the alumina-calcia ratio in a barium calcium-aluminate glass containing lithia. Composition 91 contains a larger amount of alumina and the effect on trans-

(*Continued on page* 214)

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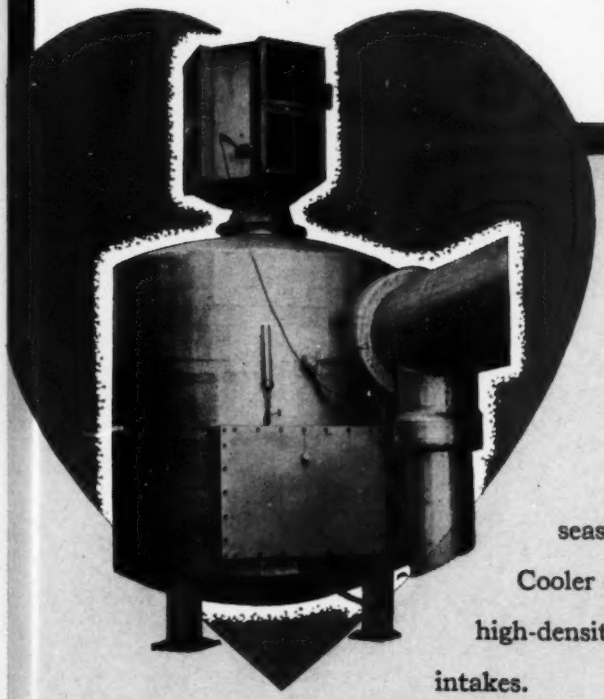

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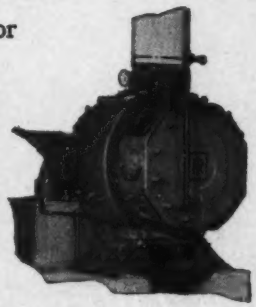

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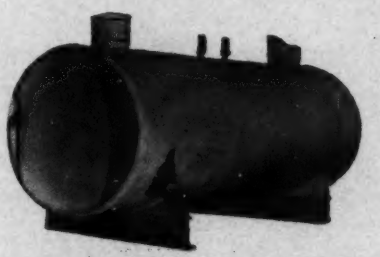

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(*Continued from page* 212)

mission is much larger than can be attributed to the difference in thickness. Figure 14 shows the effect of the soda-alumina ratio. Even though its thickness is greater, composition 101 containing more alumina is more transmissive.

Up to now some effects of composition on infrared transmission have been shown. Because of the complexity and size of the compositional area in which such effects may be demonstrated, perhaps it is best to make a general conclusion.

That conclusion is: that in promising glass systems in which infrared transmission is a criterion, compositional adjustments of many kinds may be made which have direct and interacting effects on the transmissivity. The authors have not investigated all of the effects nor even all those of considerable significance. It has been demonstrated, however, that a wide range of glasses can be made, that most of these have substantial infrared transmissivity and that the compositions are all chosen from systems in which the refractoriness is known to be sufficient to consider application as irdome materials.

The effect of temperature on infrared transmission is of considerable interest since air friction at high speeds may heat the surface of the irdome material. Figure 15 shows the effect of temperatures up to 400°C on the transmission of composition 01 which contains the oxides of barium, lanthanum, tellurium and arsenic. Note that only a slight decrease in transmission occurred with increasing temperatures. Similar measurements have been made on other compositions with even more encouraging results but the data is not as yet complete

(*Continued on page* 217)

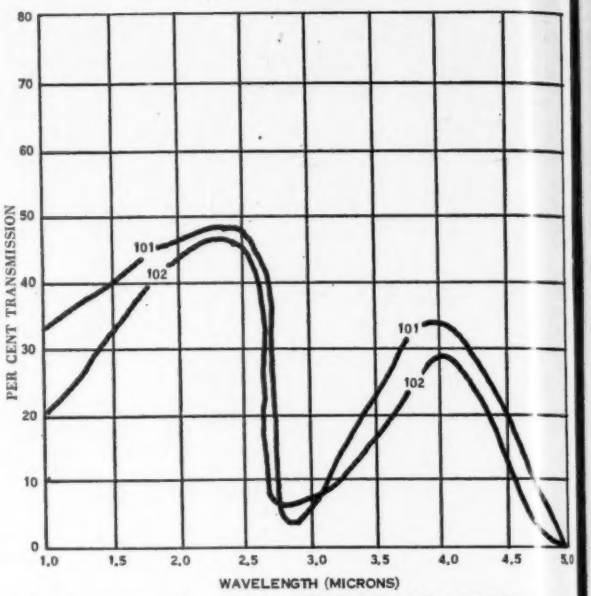

Fig. 14. Composition: 101—0.572 CM; 102—0.521 CM.

Table III

Calculated Compositions (Wt. Per Cent)

Sample	BaO	CaO	Al_2O_3	SiO_2	TiO_2	Na_2O	Li_2O	K_2O	TeO_2	La_2O_3	As_2O_3
01	49.0								36.4	1.7	12.9
02	49.0		12.0						36.4	1.7	
11	42.4			26.6	31.0						
12	42.8			30.3	26.9						
13	43.3			34.0	22.7						
14	43.9			37.7	18.4						
21	48.4			22.1	29.5						
22	49.4			29.1	21.5						
23	50.1			32.5	17.4						
24	50.2			36.7	13.1						
25	51.6			43.9	4.5						
31	40.5	9.5	9.5	40.5		..					
32	40.5	9.5	9.5	27.0		13.5					
33	40.5	9.5	9.5	13.5		27.0					
34	40.5	9.5	9.5	..		40.5					
41	46.0	12.3	10.7	31.0		..					
42	46.0	12.3	10.7	15.5		15.5					
43	46.0	12.3	10.7	..		31.0					
51	46.0	10.7	12.3	15.5		15.5					
52	46.0	10.7	12.3	..		31.0					
61	53.6	14.3	14.3	17.8		..					
62	53.6	14.3	14.3	..		17.8					
71	28.5	10.4	18.9	11.1		7.9		23.2			
72	29.1	10.6	19.3	11.4		11.8		17.8			
81	30.8	11.2	40.9	12.0			5.1				
82	33.1	12.0	43.9	..			11.0				
83	36.4	13.2	24.1	14.2			12.1				
91	55.5	10.1	27.5				6.9				
92	57.8	15.8	19.2				7.2				
101	28.7	10.4	38.1	11.2		11.6					
102	31.0	11.2	20.6	12.1		25.1					

(*Continued from page* 214)

and much work remains to be done in this general field.

The authors wish to acknowledge the contributions of personnel of the Westinghouse Research Laboratories for measurements, Air Arm Division for guidance, and Materials Engineering Departments for aid in preparing this paper. Particular thanks go to M. A. Nerenstone and E. Halpern for their work on the literature survey.

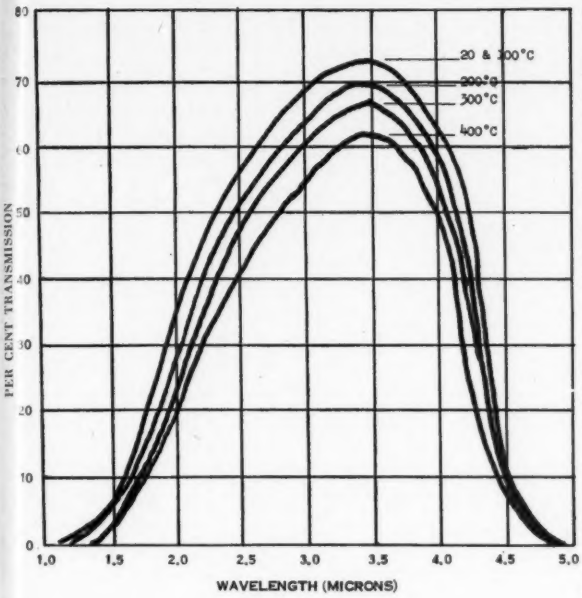

Fig. 15.

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Inventions and Inventors

(*Continued from page* 199)

The silver film is formed on a surface of the glass base having a composition within the ranges cited above by exposure of the glass base in the presence of water vapor to radiant energy in the form of light or heat. Water vapor is necessary for the film formation. While visible light is effective in producing the film, shorter wavelengths in the ultraviolet region produce the film much more rapidly. The silver film may be formed in the dark in the presence of water vapor but usually requires a period of several months as compared to a small fraction of an hour when the glass is exposed to ultraviolet or visible radiation.

Film formation occurs under a variety of conditions, but, under all conditions, water vapor must be present. The rate of formation is more rapid at higher humidities. The silver content in the glass determines the rate of film formation, also. In addition, light or heat accelerates the reaction but the silver film forms even if the glass is kept in darkness at room temperature.

When exposed to ordinary daylight under the same conditions, silver borate glasses become coated with a mirror-like film in two or three days. Films form in a few minutes by irradiating the glass with long wave ultraviolet light (3650A.), with the light from an unfiltered mercury vapor lamp (type CH_4) or with the light from a carbon arc.

The film formed is originally a non-conductor because of its extreme thinness, despite its silvery appearance. As the process continues, the film becomes thicker and becomes a conductor. Under the proper conditions, therefore, films of varying electrical resistance are produced by exposing different portions of the silver containing glass to different radiation treatments.

There were 24 claims and the following references cited in this patent.

United States Patents

572,095, Atkins, Dec. 1, 1896; 1,884,665, Greiner, Oct. 25, 1932; 2,281,076, Nash, Apr. 28, 1942; 2,314,804, Willson, Mar. 23, 1943; 2,515,940, Stookey, July 18, 1950; 2,515,943, Stookey, July 18, 1950; 2,628,160, Stookey, Feb. 10, 1953; and 2,647,068, Patai, July 28, 1953.

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Handbook of Chem. and Physics, 22nd ed., pub. 1937. Chemical Rubber Pub. Co., Cleveland, Ohio, No. 20, p. 444.

Glass Wool and Fiber

Mineral wool spinning wheel. Patent No. 2,808,616. Filed June 22, 1956. Issued October 8, 1957. One sheet of drawings; none reproduced. No assignee. Ernest C. Baldasarre and Arthur P. Gennari.

An improved spinning wheel is shown which provides many advantages over conventional mineral wool spinning wheels. The wheel has two circular end plates and a stack of flat steel rings alternating with copper rings.

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The rings and end plates are bolted so as to form a water-tight joint and an interior chamber for water cooling. Molten slag is delivered to one wheel where it is spun into wool-like fibers and, at the same time, throws the fibers at a high velocity to a second rotating wheel where attenuation is accelerated. This form of spinning wheel is said to have a plurality of advantages including low initial cost, low maintenance cost, long life, ease of replacement, reduction of idle machine time, increased production, more uniform quality of the spun product.

There were 3 claims and the following references cited in this patent.

United States Patents

2,529,962, Powell, Nov. 14, 1950, and 2,724,859, Richardson, Nov. 29, 1955.

Method and apparatus for producing fibers. Patent No. 2,810,157. Filed March 5, 1952. Issued October 22, 1957. Ten sheets of drawings; none reproduced. Assigned to Owens-Corning Fiberglas Corporation by Games Slayter and Ed Fletcher.

This invention relates to a novel method and apparatus for converting, reducing or changing materials to a finely divided state or condition. The method involves a novel utilization of forces acting on materials in a manner to fiberize, atomize or otherwise effect changes in the physical character or state of division of materials.

An object of the invention involves the establishment and application of forces acting in diverse directions upon a body of material so that the body is broken up by the forces into particles or globules, which are immediately converted to fine fibers by the forces.

There is provided a plurality of gaseous streams moving at high velocities and arranged to traverse in directions forming an X-pattern and includes feeding a body of material into the crossover zone of the blasts. The forces of the blast in angular relationship create a turbulence which act upon the material to reduce the same to fiber form by attenuation, attrition or other disintegrating or fiberizing action. The fine fibers are substantially one micron or less in diameter.

There were 24 claims and 16 references cited in this patent.

Apparatus for forming fibers. Patent No. 2,807,048. Filed December 30, 1952. Issued September 24, 1957. One sheet of drawings; none reproduced. Assigned to Johns-Manville Corporation by Lee M. Hedges.

The present invention relates to the formation of wool, or fibers, from a molten raw material and particularly to fiber spinning methods.

The invention resides in a system of multiple co-acting spinning rotors or wheels wherein molten raw material is deposited on the peripheral surfaces of the rotors and discharged therefrom by centrifugal force in the form of fibers. In previous systems of this type the rotors have been so positioned and rotated in such directions that the molten raw material has been intercepted by the rotors with considerable impact resulting in splashing or spattering of the molten material. This spattering has resulted in relatively large quantities of shot (unfiberized material) being mixed with the wool produced. The primary object of the invention is to provide a rotor

arrangement in which spattering is considerably reduced and a cleaner product is formed.

A further object is to provide a rotor arrangement in which the fiberizing rotors produce substantially equal quantities of fiber.

There were 4 claims and the following references cited in this patent.

United States Patents

2,520,168, Powell, Aug. 29, 1950; 2,520,169, Powell, Aug. 29, 1950; 2,561,843, Coleman, July 24, 1951; and 2,577,431, Powell, Dec. 4, 1951.

Sheet and Plate Glass

Apparatus for laminating glass sheets. Patent No. 2,810,668. Filed October 27, 1954. Issued October 22, 1957. One sheet of drawings; none reproduced. Assigned to Libbey-Owens-Ford Glass Company by James H. Boicey and Robert F. Leck.

This invention relates broadly to improvements in the laminating of sheets or plates of glass, and more particularly to an improved method of apparatus for laminating a plurality of units at the same time.

There is a rectangular frame which may be formed of a suitable synthetic heat-resisting material and which is provided with a plurality of rectangular openings or recesses disposed in longitudinal and transverse rows. Each row consists of three recesses and each of the recesses is of such a size and shape as to loosely contain one of the glass-plastic sandwiches to be laminated.

After the sandwiches have been placed within the frame, the frame is inserted into a flexible bag or envelope preferably formed of cellophane or similar material and which comprises an upper sheet and a lower sheet suitably joined or sealed together at their marginal edges in such a manner as to leave one edge open. After the frame with the sandwiches thereon has been placed within the bag, the edge of the bag that had been left open is sealed such as by running a hot iron or similar means along the edges of the cellophane sheets to form an airtight enclosure.

With the frame encased within the flexible envelope and the edges thereof sealed together, the bag assembly is evacuated so as to remove residual air.

With the vacuum still being applied to the envelope, the bag assembly is placed within a tank wherein final lamination takes place. Before the bag assembly is inserted within the tank, the temperature of the oil or other liquid is raised to approximately 250°F. The bag is then clamped to a support and, with the vacuum continued, immersed in the heated liquid for a sufficient length of time to soften the plastic interlayer.

The vacuum is then discontinued and the bag left within the tank for approximately 20 minutes at a temperature in the order of 250°F. After this period of time has elapsed, the sandwiches are laminated and may be removed from the bag.

There were 5 claims and the following references cited in this patent.

United States Patents

1,887,550, Fix et al., Nov. 15, 1932; 1,887,565, Shirts, Nov. 15, 1932; and 2,054,868, Owen, Sept. 22, 1936.

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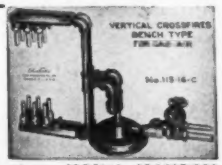

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FOR THE GLASS INDUSTRY

LANCASTER, OHIO U. S. A.

Foreign Patents

488,315, Great Britain, July 5, 1938.

Apparatus for manufacturing flat glass in ribbon form. Patent No. 2,826,005. Filed September 30, 1954. Issued March 11, 1958. No sheets of drawings; none reproduced. Assigned to Pilkington Brothers Limited by Hubert C. Wynne.

The present invention comprises apparatus for manufacturing a sized ribbon of glass characterized by compressing and effecting a heat exchange with the marginal portions only of the ribbon. A tractive force is applied to said marginal portions so that the ribbon is positively

advanced lengthwise as it is formed. The intermediate body portion of the ribbon is progressively subjected to a compressive force directed through a heat insulating gaseous layer whereby the thickness desired for the said body portion of the ribbon is obtained and a fire-polished condition obtained thereon.

The invention also provides apparatus for manufacturing a sized ribbon of glass, which comprises in combination with a casting roller of normal design arranged below the spout of a glass furnace, coaxial driving rolls juxtaposed to the spout and disposed with respect to the casting roller so as to engage and compress the marginal portions only of the ribbon of glass formed on the casting roller. The apparatus then draws forward the ribbon, a spinning roller of a length to overlie the full width of the intermediate body portion of the ribbon adjacent to the driving rolls. A gaseous layer is produced on the periphery between the roller and the ribbon, whereby as the ribbon is being sized the layer acts as a heat-insulating medium between the glass and the roller. By such method of manufacture heat transfer to the roller is obstructed by the presence of the heat-insulating gaseous layer.

This gaseous layer may be produced by introducing an inert gas into the interior of the roller under such conditions that the gas will percolate through the wall of the spinning roller as the latter rotates.

It is known that a roller having a porous graphite wall produces a clinging film of air upon its surface if the latter is rotated so that the linear speed of the surface of the roller is about three thousand inches per minute.

The main object of the invention is to provide improved means of minimizing interruption of production by sizing the ribbon of glass while reducing the conduction of heat to the sizing means and at the same time achieving a regular progressive movement of the glass through the sizing means.

There were 6 claims and the following references cited in this patent.

United States Patents

1,435,958, Fowle et al., Nov. 21, 1922; 1,657,214, Kutchka, Jan. 24, 1928; 2,336,510, Spinasse, Dec. 14, 1943; 2,387,886, Devol, Oct. 30, 1945; 2,505,103, Devol, Apr. 25, 1950; and 2,598,893, Drake, June 3, 1952.

Tube and Cane Machines

Apparatus for butt welding glass capillary tubes. Patent No. 2,864,793. Filed October 27, 1954. Issued October 7, 1958. No sheets of drawings; none reproduced. Assigned to Vapor Heating Corporation by Sam J. Johnson and Don A. Brosseau.

The invention contemplates the provision of a novel form of tube-clamping mechanism. The two tube sections to be joined are maintained in non-rotatable vertical alignment, together with means whereby one of the tube sections may be moved relative to the other during the actual butt welding and necking operations in a controlled manner so as to insure uniform welding and shaping operations on the successively joined pairs of tube sections. The invention further contemplates the controlled application of heat to the tube sections at various locations therealong, utilizing flame-producing jets for this purpose which are shiftable in the vicinity of the butt weld and are capable of selectively producing moderate and intense flame characteristics for purposes of preheating the tube ends and of performing the actual butt welding and necking operations.

The apparatus thus provides a means for butt welding the ends of glass tubes together so that the joined sections assume positions of perfect alignment.

There were 7 claims and the following references cited in this patent.

United States Patents

766,321, Burrows, Aug. 2, 1904; 1,004,072, Pierson, Sept. 26, 1911; 1,832,039, Millar, Nov. 17, 1931; 2,296,347, Hinkley et al., Sept. 22, 1942; 2,447,569, Eisler, Aug. 24, 1948; and 2,488,126, Kahle, Nov. 15, 1949.

Lamp sealing apparatus. Patent No. 2,844,917. Filed October 21, 1953. Issued July 29, 1958. No sheets of drawings; none reproduced. Assigned to General Electric Company by Richard Gladen Caldwell.

The invention relates in general to the manufacture of electric lamps of the double-ended type having a mount sealed into each end thereof, and more particularly to apparatus for sealing the mounts into the opposite ends of the tubular envelope of the lamp.

Two conventional turret-type lamp-sealing machines are positioned in adjacent side-by-side relation with a common drive means for indexing them in timed relation with each other. A horizontal transfer arm provided with lamp gripping means, and operating in timed relation to the index movements of the sealing turrets, is mounted in a position between the two sealing turrets and is arranged to grip the lamp at the unloading station of one of said turrets and then swing in a horizontal plane and rotate about a horizontal axis to simultaneously transfer and invert the lamp and place it in a lamp holder of the second turret at the loading station.

It is the object of the invention, therefore, to provide a sealing apparatus for tubular type lamps which will operate to seal automatically one end of a tubular lamp envelope and then invert the lamp and seal the other.

There were 5 claims and the following references cited in this patent.

United States Patents

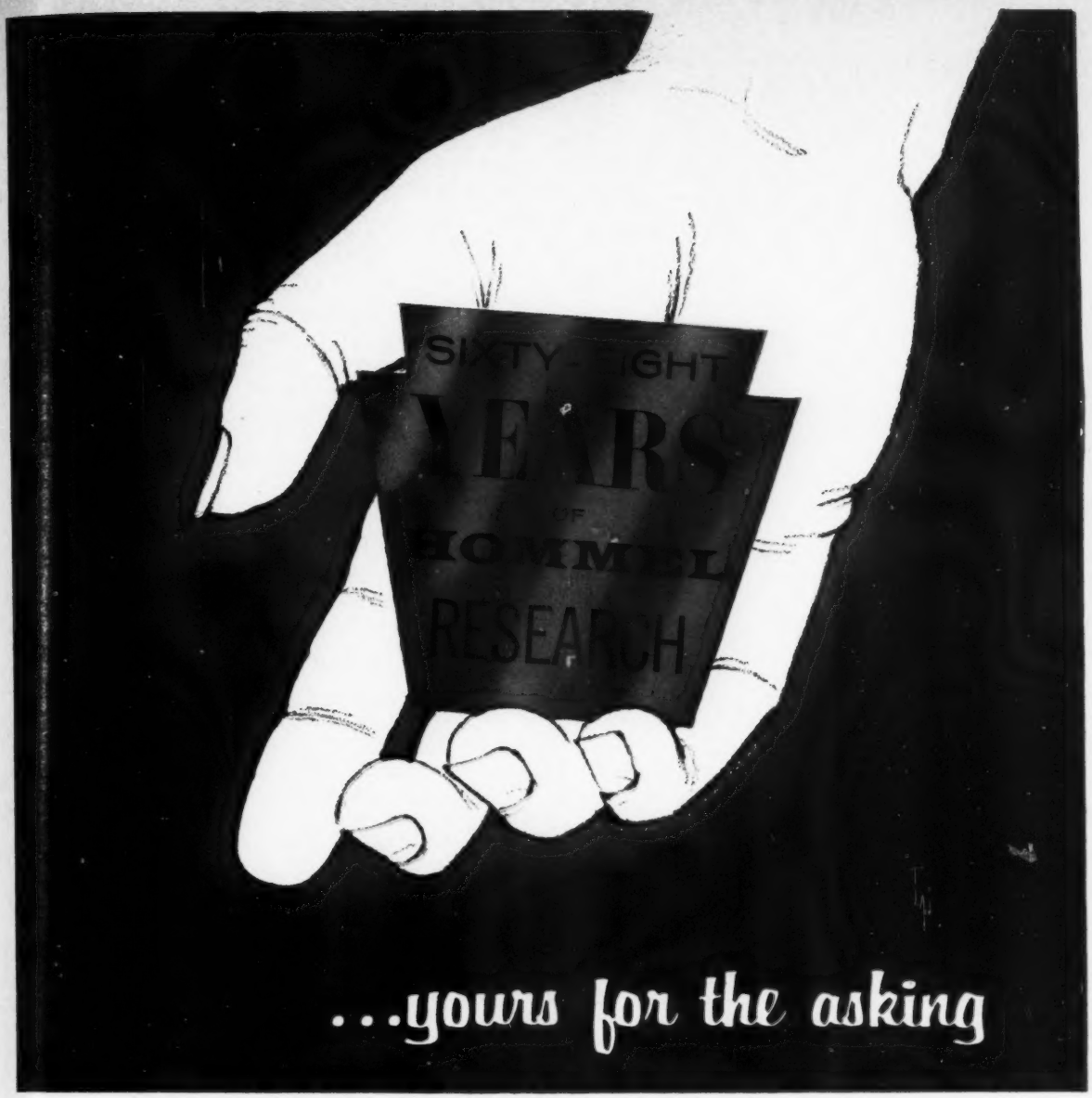
2,023,628, Van Sant, Dec. 10, 1935; 2,077,827, Dichter, Apr. 20, 1937; 2,194,755, Kell, Mar. 26, 1940; 2,434,664, Malloy, Jan. 20, 1948; 2,449,637, Blake et al., Sept. 21, 1948; and 2,597,283, Brooks, May 20, 1952.

Phosphate coating of incandescent lamp. Patent No. 2,843,504. Filed February 14, 1955. Issued July 15, 1958. No sheets of drawings; none reproduced. Assigned to North American Philips Company, Inc. by Henricus Antonius Van Bakel and Theodorus Adrianus Maria Gast.

In accordance with the invention, there is provided on the internal surface of a light, transparent envelope (adapted to house an incandescent filament) a coating of a water-insoluble alkaline-earth phosphate, preferably having an apatite structure. Such coatings transmit over 95 per cent of the light generated by the filament, while preventing the filament from shining through.

Excellent results are produced when the suspension of the water-insoluble alkaline-earth phosphate contains

(*Continued on page* 222)



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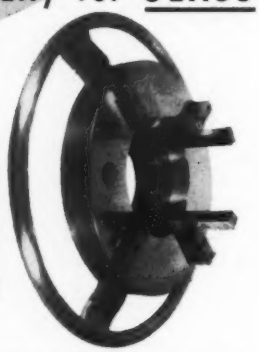

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(*Continued from page* 220)

in addition at least 1.5 per cent of phosphoric acid (based on the phosphate). Other acids which liberate the required amount of phosphoric acid from the phosphate, such as for example, hydrochloric acid, may be used. The suspending medium used is a water-mixable, volatile, organic liquid to which water (preferably about 3 per cent based on the phosphate) is added. As the volatile, organic liquid we may use methanol, ethanol, acetone or methyl ethyl ketone.

This suspension is applied to the bulb surface and is dried by a flow of air. The drying air may be heated if desired. After the layer is dried it is heated above approximately 200°C. This process produces a layer that adheres very well to the bulb surface. In those areas at which parts are to be sealed to the bulb surface it is necessary that the layer be removed prior to the heating above 200°C.

The phosphate may be used in the form of orthophosphates, metaphosphates or pyrophosphates; for example, $Ca_3(PO_4)_2$, $Mg_2P_2O_7$ and $Ba(PO_3)_2$. However, best results are obtained when the phosphate used has the apatite structure. Suitable apatites are, for example, halogen apatites such as fluoroapatite having the formula $3Ca_3(PO_4)\cdot CaF_2$, or a hydroxy-apatite having the formula $3Ca_3(PO_4)\cdot Ca(OH)_2$.

There were 3 claims and the following references.

United States Patents

2,324,079, Greger, July 13, 1943; 2,684,306, Brewer, July 20, 1954; 2,686,734, Sadowsky, Aug. 17, 1954; 2,691,601, Butler, Oct. 12, 1954; 2,704,726, Markoski, Mar. 22, 1955; and 2,706,691, Schaefer, Apr. 19, 1955.

Miscellaneous Processes

Method of sealing a port in a glass object. Patent No. 2,814,100. Filed January 2, 1953. Issued November 26, 1957. One sheet of drawings; none reproduced. Assigned to The Commonwealth Engineering Company by Alfred Lippman, Jr.

This invention relates to seals and more particularly to seal structures for glass.

A tapered hole may be drilled in the wall of a 1/16 inch thick glass plate, the hole having an outside diameter of about 3/16 of an inch and an inside diameter of about 1/8 of an inch. The walls of the hole or port will have a roughened surface as a result of the grinding and may be either used in this condition or may be smoothed off as desired for the receipt of a thin wall metal insert having a silicone rubber gasket secured around the lower peripheral portion thereof for air-tight engagement with the wall.

The temperature of the insert may be raised by the above means to 350-400°F. Thereafter hydrogen is introduced centrally through the housing as set forth hereinbefore, vacuum being applied to the housing simultaneously with the introduction of the hydrogen to clear the housing of air and create a hydrogen atmosphere over the port. Thereafter jets of nickel carbonyl gas borne by a hydrogen carrier gas are introduced through the inlets, the heat of the insert being effective to cause decomposition of the gas, the deposition of metal over the insert and on the glass walls.

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A flow rate through each port of about 1 liter per minute at a concentration of metal-bearing gas of 25 per cent volume is satisfactory.

After the port has been sealed with metal, the seal of the housing is broken, the housing removed, and if desired the metal seal may be polished slightly. Such a seal will be entirely impermeable, resistant to changes in temperature between the limits of minus 40°F. to 150°F. and will give excellent results in salt spray tests.

There were 4 claims and 11 references cited in this patent.

Apparatus for withdrawing masking material from bulbs. Patent No. 2,811,394. Filed April 10, 1953. Issued October 29, 1957. No sheets of drawings; none reproduced. Assigned to Westinghouse Electric Corporation by Theodore F. May and Charles R. Edgerly.

This invention relates to coating the interior surfaces of translucent vitreous envelopes with specular material, perferably metal such as silver or aluminum.

An open neck glass bulb or envelope is inverted. A measured quantity of granular masking material, preferably fine glass granules, is then poured therein as from a receptacle or other bulb. The granular material is desirably, "Barium Crown Glass Beads," preferably .014" in diameter. This granular material may be evenly distributed in the bowl portion of the bulb in any desired manner, preferably by twirling.

After being so distributed, the bulb is placed in a coating machine described in Green patent No. 2,569,-852, October 2, 1951. The metal is flashed to apply a specular coating to the unmasked portions of the bulbs.

The flashing filament is desirably formed of flattened tantalum wire rather than tungsten wire, as such wire has been found to work better with silver than tungsten wire.

After flashing has been completed, the bulb is removed and placed on a Bakelite support and made ready for the removal of the masking material.

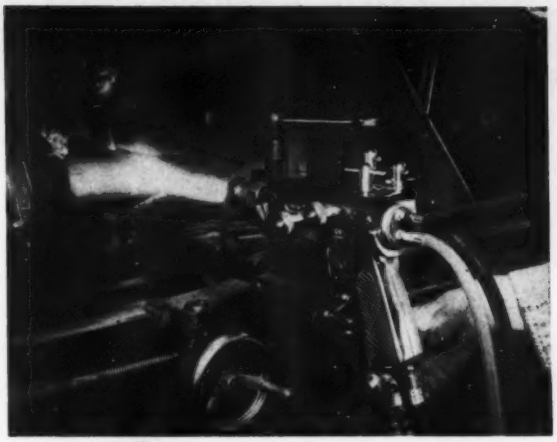
A vacuum suction tube is provided for withdrawing the masking material from the interior of each bulb after coating on the machine.

The tube, in turn, connects with a hopper for receiving the masking material after it is withdrawn from a bulb.

There were 4 claims and the following references cited in this patent.

United States Patents

219,019, Renard et al., Aug. 26, 1879; 228,206, Luckenbach, June 1, 1880; 692,106, Bedarrides, Jan. 28, 1902; 1,495,487, Johnson, May 27, 1924; 2,247,432, Birdseye et al., July 1, 1941; 2,349,444, McGowan, May 23, 1944; 2,447,337, Hoch, Aug. 17, 1948; 2,569,852, Green, Oct. 2, 1951; and 2,658,657, Fechheimer, Nov. 10, 1953.



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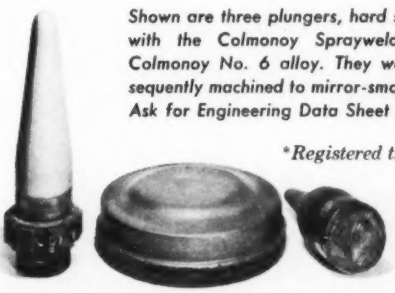

Shown are three plungers, hard surfaced with the Colmonoy Spraywelder and Colmonoy No. 6 alloy. They were subsequently machined to mirror-smoothness. Ask for Engineering Data Sheet No. 34.

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